BRAIN.

PART III., 1894.

Original Articles and Clinical Cases.

ON DISTURBANCES OF SENSATION WITH ESPECIAL REFERENCE TO THE PAIN OF VISCERAL DISEASE.[1]

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Part II.—Head and Neck.

Introductory.

In a previous paper[2] I pointed out that visceral disturbances produced pain at certain points on the surface of the body, and that this pain was frequently accompanied by more or less definite areas of superficial tenderness. But in this first communication I neglected all pain and tenderness above the level of what I called the area of the first dorsal segment. In the present paper I intend to treat of similar phenomena above this level, and to describe the situation of pain and tenderness in the head and neck produced by visceral disturbances.

An enormous literature has grown up around the subject of headache, reaching from the earliest times up to the present day. In almost every case the observer has noted the position to which the headache was referred and has subsequently classified the observations so obtained according to the disease from which the patient might be suffering. If I shall appear to neglect this mass of observations my excuse must be that they mostly relate to the position of the pain.

[1] Read before the Neurological Society, July 12, 1894.

[2] Brain, 1893.

Now the locality of the pain is instructive only when we know the area of tenderness with which it is usually associated. This tenderness, which is necessary to the full understanding of the locality of the pain, has been neglected, or at any rate dealt with in such a fragmentary manner as to be useless. Moreover, in order to estimate the value of any one factor in the causation of headache, the examination must be of a completness impossible in ordinary practice. For if the eye surgeon notes the position of the headache in those patients who come to him with errors of refraction, he will come to the conclusion that almost any part of the head may be affected. In the same way the general physician will find that affections of the stomach will be accompanied by headache in equally numerous situations. Now in each instance the attention of the observer is concentrated on one organ only, and he notes the one positive detail but does not exclude the possibility of other coexistent, but independent causes.

The system I have adopted in determining the areas associated with any particular organ of the head has been to first exclude all pain and tenderness in the thorax and abdomen; then I noted the presence or absence of general states, *e.g.*, anæmia; lastly I excluded disturbances of other organs than the one under observation. After rejecting the cases which did not satisfy these tests a certain number of observations remained pointing directly to a relation between the organ in question and certain areas of tenderness. After determining that certain pain and tenderness was due to disturbance of a certain organ, the results of treating that disturbance were noted, *e.g.*, the effect on the headache produced by correcting an error of refraction. If the correction was successful it formed another link connecting a certain area of tenderness with the disturbance in a certain organ. Thus it is not sufficient to say that a headache is due "to the eye" or "to the teeth" unless we note the direct effect produced by treating the eye or removing the teeth.

On the other hand, when determining the relation of pain and tenderness in the head and neck to disturbances of thoracic and abdominal organs the converse precautions

were taken. It is not sufficient to note that a certain headache appeared in a patient suffering from some thoracic or abdominal lesion, unless his eyes, ears, nose or throat had been examined to exclude the possibility that the headache might be due to disturbance of some one of these organs.

Thus throughout this laborious investigation completeness of record, rather than number of cases, has been the aim. Moreover an enormous number of observations made at the beginning of each new phase of the investigation were subsequently rejected, owing to an incompleteness in the records which must necessarily mark the stage of advance. Thus it is useless to say that the work is based on so many hundred or thousand cases, for if any advance has been made the earlier records must of necessity be incomplete, and if no advance has been made, why multiply cases?

In this paper I attempt to show the following points:—

(1) Each organ in the head stands in relation with one or more areas on the surface. To these areas pain is referred, and over them the skin may become tender, when the normal condition of that organ is disturbed.

Such organs are the nose, the eye, the ear, the teeth, the tongue, the salivary and other glands, the tonsils, the larynx, and lastly, the brain itself. (Chap. ii.)

(2) I then treat of herpetic eruptions on the head and neck, and attempt to show that in certain cases they correspond fairly with the areas of tenderness produced by visceral disease. But, owing to the tendency of such eruptions in the head to involve several areas, the distribution of herpes of the head and neck is not of the same corroborative value as that of herpes on the trunk and abdomen. (Chap. i., § 2.)

(3) These areas do not for the most part overlap to an extent that can be appreciated clinically. Some of them, however, overlap distinctly, especially such as lie in parts of the neck where compression has taken place. But however great may be the overlap, it never even approximates to that which Sherrington[1] showed occurred in the distribution of every posterior root. (Chap. i., § 4.)

[1] *Phil. Trans.*, vol. clxxxiv.

(4) I attempt to map out the distribution of the fifth nerve by observing the results produced by destroying its branches in man. An examination of the results shows that my tender areas do not correspond to the distribution of the branches of the fifth nerve. (Chap. v.)

(5) As elsewhere in the body, the serous cavities and superficial structures do not cause referred but local pain. Thus an affection of the dura mater causes as local a pain as inflammation of the pleura or peritoneum, and injuries to the conjunctiva or anterior layer of the cornea cause no more referred pain than affections of the skin. (Chap. iv., § 1.)

(6) The phenomena of true megrim are then touched upon, and I attempt to show that it bears no relation to the phenomena of referred pain. Not only is it unaccompanied by superficial tenderness, but the pain follows lines that differ from those of referred pain. (Chap. iv., § 2.)

(7) I attempt to show that affections of the thoracic and abdominal viscera not only produce pain and tenderness in the body, but also cause pain and tenderness over certain areas of the scalp. The position of the headache is not governed by the dyscrasia or, directly, by the thoracic or abdominal organ which is affected. It stands, however, in direct relation to the position of the area of tenderness on the surface of the body. Thus we must not speak of "anæmic" or "cardiac" headaches, but rather of the headache correlated to this or that dorsal segmental area. Whatever be the organ affected the headache and scalp tenderness will be in the same position, provided the tenderness on the body occupies the same areas. (Chap. iii.)

(8) Finally, I treat of certain theoretical aspects of this work, and attempt to localise the central connection of these areas with the nervous system. At the same time an attempt is made to split up that complex of nerves known as the sensory part of the fifth into its elements, and to assign the great vagus nerve to its place in the cranial nerve group. (Chap. vi.)

To facilitate reference, the following indications may be found useful by those interested in special departments, touched on in this paper:—

Ophthalmology.—Chap. i., § 1 (p. 343 to p. 353); chap. ii., § 1 (p. 394).

Dental Surgery.—Chap. i., § 1; chap. ii., § 2 (p. 406).

General Medicine.—Chap. i., § 1; chap. iii. (p. 436).

Anatomy.—Chap. i., § 1, 3 (p. 386), and 4 (p. 391), chap. v. (p. 469), and vi. (p. 475).

CHAPTER I.

Topographical.

§ 1. *The position of the Areas of Tenderness in the Head and Neck.*

A. *The Dorsal Areas.*

When an organ in the head is diseased, the pain produced is frequently associated with superficial tenderness. Organs in the head behave in the same way as organs in the thorax and abdomen, and produce not only referred pain but also tenderness of the superficial structures in direct association with the referred pain. In my previous paper the methods of marking out these tender areas were described, and the characteristics of the areas discussed. Excepting in the region of the limbs these zones on the body fell into very simple forms. In the head and neck, on the other hand, a profound disturbance has been produced, and the primitive arrangement has been fundamentally altered by the shifting of the elements of the head on one another. I shall therefore begin by describing those areas which lie above a certain line. This line starts in the region of the nose, follows the lower margin of the bony orbit, runs directly back from the orbital process of the frontal bone to the upper part of the insertion of the ear, and then dips to form a curved line ending below the occipital protuberance.

Several methods are useful for testing superficial tenderness on the scalp, face and neck. On the forehead and hairy scalp, where there is a firm bony substratum, I use the blunt end of a pin; this is felt as a blunt touch until the tender area is reached. The patient then complains either that the

touch hurts and the skin is "tender," "like a bruise," or else he may say that he is being pricked.[1]

If the tender area lies over the hairy scalp, a useful method is gently to pull upon or lift the hair. This is perfectly painless in the normal human being, but becomes painful if superficial tenderness is present over the scalp. Thus patients suffering from referred pain and tenderness will complain that their hair is sore when they brush it in the morning.[2]

On the cheeks there is danger that the head of the pin may exert pressure upon tender underlying structures, such as the teeth, and it is therefore advisable to support the cheek with the finger placed inside the mouth.

In every case it is best to use at least two methods, and to state which form of stimulation has produced the results figured on the recording chart.

The method I adopt in working out a case is as follows:—First the patient is asked to point out the situation of the pain. Then I rapidly test the skin, beginning from a part of the head over which sensation is unaltered, and working towards the hyperalgesic patch. Marks are made to show the points at which the tenderness begins. Then the history is taken or the patient engaged in conversation. After a time a second estimation is made. If the case be one of disease of the eye, ear, &c., I make a third estimation after the patient has been subjected to refraction testing, ophthalmos-

[1] A word of warning is necessary with regard to the shape of the head of the pin. The pins I use have spherical heads, whilst the heads of the usual pins of commerce are segments of a sphere only. This difference is of no importance when testing tenderness on the body, for the pin can always be applied at right angles to the surface. On the other hand it is not so easy always to apply the pin at right angles to the surface of the scalp or forehead, and thus if the ordinary pin is used stimulation may inadvertently be made with the edge of the head, which is definitely sharp to the normal skin. To avoid this source of error I choose a pin with a spherical head which can never seem anything but blunt to the normal skin however obliquely the pin may be held.

[2] Women who have changed the method of dressing their hair suffer from tenderness of the scalp for some time after the change. They do not, however, react to the blunt head of a pin.

The bald scalp would at first sight appear an excellent field for tracing the limits of these areas. However, with the fall of the hair, the scalp seems to become less sensitive. Thus, though the shaved scalp forms a superb field for investigation the naturally bald scalp is comparatively unsatisfactory.

copic or laryngoscopic examination, &c. It is very important neither to tire the patient, nor on the other hand, to concentrate his attention on the patch of tenderness. Over the head and neck marks made on the skin are fortunately invisible to the patient himself. The limits of the area should not be measured until the whole examination is finished. The areas are then transferred to a chart, or in the case of a variable part like the neck to a drawing made on the spot. The edges are either very roughly shaded, or else marked with greater definiteness by lines, according to the degree of accuracy with which the patch of tenderness could be defined.

On those parts of the head and neck which are free from hair, heat and cold will also serve to differentiate the areas of tenderness ; but this method is clumsy, and the limits cannot be so clearly defined as by the other methods. It is however, theoretically interesting as showing the existence of exaggerated sensibility to heat and cold over these tender areas.

There was comparatively little difficulty in determining the relation of the areas on the trunk to the central nervous system, and I therefore felt justified in replacing the cumbrous regional names by names implying a relation to segments of the cord. With the areas of the head and neck this is impossible, except on purely hypothetical grounds, and I shall therefore give each area a name which in no way implies connection with any part of the nervous system, but simply relates to its regional distribution. In a subsequent chapter I shall attempt to show how far we are justified in assuming that these areas bear any relation to the segmentation of the upper part of the nervous system.

Fronto-nasal.

This area forms a racquet-shaped patch with the larger part lying over the forehead. It extends for from 2 to $2\frac{1}{2}$ inches (5 to 6·5 cm.) above the root of the nose, reaching the junction of the hairy scalp with the forehead. It meets its fellow of the opposite side excepting just over the root of

the nose. At the level of the eyebrow it extends out for from $\frac{3}{4}$ to 1 inch (2 to 2·5 cm.) from the middle line of the forehead. A downward flap occupies the side of the nose, but does not reach the middle line and ends below, above the upper part of the ala nasi (fig. 1).

The maximum point of this area lies over the orbital ridge of the frontal bone about $\frac{1}{2}$ inch (1·5 cm.) from the middle line of the forehead.

The pain is said to be an aching "over the middle of the forehead," and the patient points to the left or right of the middle line, over the supra-orbital notch.

This area becomes tender in affections of the substance of the cornea, anterior chamber of the eye, upper part of the nose and incisor teeth of the upper jaw.

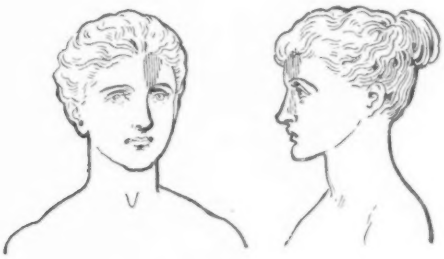


FIG. 1.

To show the area of superficial tenderness in a case of so-called serous iritis (Case No. 1). The tenderness follows the fronto-nasal area.

Case 1.—Harriet Q., aged 19. (Mr. Tweedy.)

She has had weak eyes since she was young, but they have been much worse during the last two months. She had attended the eye department on many occasions with similar attacks to the present one. The present attack began two weeks before I saw her.

The left anterior chamber is deep. Keratitis punctata and serous iritis. Slight ciliary injection. Tension of the eye as a whole normal. Right eye quiet but shows signs of past interstitial keratitis.

She complains of pain over the left side of the front of the forehead. Definite superficial tenderness as in fig. 1.

No pain or tenderness elsewhere in the body or head. No affection of the nose.

Menstruation regular and painless. Not anæmic.

Appetite good. No pain after food. No vomiting.

The next day the tenderness was equally well marked, but it gradually faded and had disappeared at the end of a week.

Mid-orbital.

This area, when fully developed, consists of two portions separated from one another. The lower part is roughly triangular, about 1 to 1½ inches (2·5 to 4 cm.) in height, by about 1 inch (2·5 cm.) across the base. It is situated over the centre of the eyebrow and involves the greater part of the upper lid. It sends a downward flap which occupies the inner (nasal) half of the lower lid. The second portion of this area is situated over the extreme front of the hairy scalp about 2½ inches (6·5 cm.) above the level of the root of the nose, and exactly above the patch on the forehead. The posterior limit of the scalp portion is about 2 to 3 inches (5 to 7·5 cm.) in front of a line drawn vertically from ear to ear. It is exactly over the fringe in a woman. The two portions are mostly distinctly separated from one another, but when this area is very well developed the upper part of the patch over the eyebrow comes very close to the anterior portion of the area on the front of the scalp (fig. 2).

A word of warning is necessary here. Directly we begin to work within the limits of the hairy scalp the boundaries of the tender zones cannot be determined with the distinctness that is possible over the forehead. For, owing to the presence of the hair, it is difficult to mark out the limits of the tender patch, and to see how nearly the second estimation resembles the first.

The more important maximum of this area lies over the upper part of the upper lid, just below the centre of the eyebrow. A second maximum exists over the patch on the front of the hairy scalp. In the large majority of cases the maximum over the centre of the eyebrow only, is present.

When this area is affected the pain is said to be "at the back of the eye" or "over the middle of the eyebrow."

The eyes are said to ache, and sometimes the patient complains of soreness "over the front of the hair."

If asked to point to the position of the headache when this area is represented on both sides of the forehead, the patient usually places the right hand over the front of the forehead. The thenar eminence is over the centre of the right eyebrow, and the fingers touch the middle of the left eyebrow. Thus one might easily be misled into thinking that the headache was truly "frontal." But when the patient is asked to point with two hands to the position of his headache, he places the tips of the fingers of each hand over the middle of the eyebrow on the respective side thus showing that the headache is not really in the centre of the forehead. This source of fallacy has not been recognised by those who have studied the situation of pain only.

FIG. 2.

To show the areas of superficial tenderness in a case of hypermetropia (Case No. 2). The tenderness marks out the mid-orbital area.

Case 2.—William G. (Mr. Tweedy.)

Complains that he cannot see to read especially with the left eye.

Vision.—Right eye $\frac{5}{60}$ Jæger 6.
Left eye $\frac{3}{60}$ Jæger 14.

He complains of pain "over the eyes." His eyes "ache when he reads."

Superficial tenderness over the areas in fig 2.

As he was doing no work, he was put under atropine, and at the end of a week all headache and tenderness had disappeared.

Right eye.—Vertical + 2·25D.
Horizontal + 3D.
Left eye.—Vertical + 5·75D.
Horizontal + 6D.

Right eye with + 2 D. spherical, and + 0·5D. cylinder axis vertical he saw $\frac{6}{6}$.

Left eye with + 5D. spherical, and + 0·75D. cyclinder axis 45° he saw $\frac{6}{12}$.

He was in every way a typically healthy youth.

Fronto-temporal.

This area rises from the outer part of the eyebrow with a curve towards the middle line. It laps on to the outer part of the upper lid, and takes the whole of the outer half of the lower lid. It rises for about 3 inches (7 cm.) above the external canthus of the eye, and the inward curve brings it in contact with the fronto-nasal area about $1\frac{1}{2}$ inches (4 cm.) from the middle line of the forehead. At the level of the eyebrow its anterior border is about 2 inches (5 cm.) from the middle line of the forehead. Its posterior border is about $3\frac{1}{4}$ inches (8 cm.) from the centre of the forehead or 5 inches (7·5 cm.) in front of the anterior part of the insertion of the ear. Thus the gap between the two portions of the mid-orbital area is filled approximately by the upper and anterior parts of the fronto-temporal area. Its anterior border abuts on the mid-orbital below, then on the fronto-nasal, and above on the upper or scalp portion of the mid-orbital (fig. 3).

The maximum spot of this area lies about half an inch above the orbital ridge of the frontal bone, and is easily distinguished by lying somewhat above the level of the maxima of the surrounding areas.

The pain associated with this area is said to be "over the forehead," if it is present on both sides, or "over the temple," if it be represented on one side only. If the patient is asked to point with both hands to the position of the headache, the hands assume a very characteristic attitude. The flat of each hand, with the fingers upwards, is placed over the anterior part of the temple so that the ulnar border of the little finger rests just above the outer part of the eyebrow. All the fingers converge to the centre of the forehead, and the appearance presented by the patient is thus very characteristic.

This but rarely occurs alone in disease of the organs of the head (*cf.* fig. 33), but is common as one of the areas of reference from the thoracic viscera. It occurs frequently in iritis, and, in conjunction with the temporal area, in glaucoma.

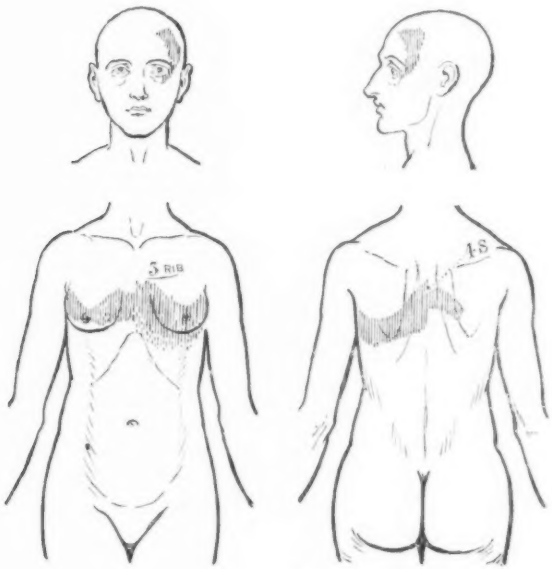


FIG. 3.

To show tenderness of the scalp over the fronto-temporal area. From Case No. 3 (mitral stenosis).

Case 3.—Emily E.[1] (Victoria Park, Dr. H. Sainsbury), aged 36.

Rheumatic fever at 13 years. Second attack at 27 years. Since then "heart has been affected."

Some cyanosis; pulse 100, regular.

[1] I cannot report cases of cardiac and pulmonary disease as fully as I should wish in this section, but can give the salient points only. Most of these cases will be reported in full in my paper on "Mental States in Visceral Disease."

First sound accentuated short and sharp; preceeded by a slight rough murmur; followed by a systolic murmur.

No enlargement of the liver.

No swelling of the feet. No ascites.

Pain over the third and fifth spaces in about nipple line. Also under angle of left scapula. Superficial tenderness over the areas of the fifth and sixth dorsal segments on the left side, and over the fifth dorsal on the right side of the chest.

Headache "over left temple." She places her finger $2\frac{1}{2}$ (6·5 cm.) inches from the middle line over the orbital ridge of the frontal bone. Marked superficial tenderness as in fig. 3.

She remained under observation for six weeks in the hospital, and this form of headache, amongst others, appeared and disappeared several times.

The eyes were normal. No decayed teeth.

Temporal.

This area lies directly over the temporal fossa, and extends upwards for from 3 to 4 inches (7·5 to 10 cm.) above a line joining the external canthus of the eye with the upper part of the insertion of the ear. Its anterior border is about 3 inches (7·5 cm.) from the middle line of the forehead, and about half inch (1 to 2 cm.) in front of a vertical line drawn upwards from the insertion of the ear. Its breadth is about 2 inches (5 cm.) at the widest part (fig. 4).

The maximum lies in the temporal fossa just above the upper border of the zygoma.

The pain is said to be "in the temple," or if bilateral to "shoot through from temple to temple."

This is an exceedingly important area, and appears in affections of the vitreous chamber of the eye (glaucoma), and with caries of certain teeth in the upper jaw. Its great importance arises from the fact that it is associated with the upper gastric area (seventh dorsal) of the chest, and it is therefore peculiarly associated with the presence of nausea and vomiting.

Case 4.—Maria P. (Mr. Tweedy), aged 67.

February 26. At four o'clock yesterday afternoon she was seized with pain in the right eye. Her sight left her and at six p.m., she began to vomit. The vomiting continued till eight a.m., this morning.

FIG. 4.

From a case of acute glaucoma (Case No. 4). To show superficial tenderness over the temporal area. Some tenderness is present, in a less degree, over the mid-orbital area.

She now has intense pain in the right temporal region, with much slighter pain over the centre of the right eyebrow. The back teeth of the upper jaw ache.

There is marked superficial tenderness over the area in fig. 4.

The cornea is steamy, anterior chamber shallow, pupil of medium size, regular in outline. Tension + 3.

Drops of eserine gr. i. to the ʒj. relieved her greatly.

In the evening Mr. Tweedy did an iridectomy upwards.

February 27. She is now free from pain.

March 18. Wound healed well. All pain and tenderness has been absent since the operation.

The case was a typical one of acute glaucoma.

Vertical.

This area lies exactly over the vertex and abuts in front on the posterior limit of the mid-orbital, fronto-temporal, and temporal areas. Posteriorly it generally just crosses a line drawn vertically from the insertion of one ear to that of the ear on the opposite side. It is roughly triangular in shape, and the apex of the triangle reaches to a point just above and in front of the insertion of the ear. We have now reached that part of the head which varies most in measurement, and it is therefore very difficult to give the limits of this area in inches. Roughly, however, its base along the middle line of the scalp measures about 2 inches (5 cm.). It is best characterised by its relative position to the vertical line from ear to ear, and by the fact that it does not include the extreme anterior portion of the hairy scalp (fig. 5).

The maximum of this area lies just in front of the vertical line joining the ears, and to the right or left of the middle line.

The pain of this area is very definite and is said to be "on the top of the head." The patient puts his hand exactly over the vertical maximum.

This area appears in affections of the extreme posterior portion of the eye and is the hindmost of the eye areas. It also appears with pent-up discharge or rise of tension in the middle ear. It is also associated with hepatic and gastric disturbances, and frequently stands in relation with the well-known "headache on the top of the head" in such disorders.

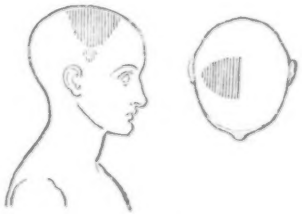


FIG. 5.

To show superficial tenderness over the vertical area of the scalp. From Case No. 5 after excision of the right eye.

Case 5.—Helen B. (Mr. Tweedy), aged 64.

Six months before admission she began to suffer from chronic glaucoma. On admission the right eye was blind. Cornea sodden. Iris dilated. Tension + 3.

She complained of pain around the eye and I therefore excised the right eye, under Mr. Tweedy's guidance.[1]

During the few days she was under observation in the hospital before the operation, no tenderness was present. During the night after the excision she complained of headache on the top of the head, and this headache was associated with distinct superficial tenderness of the scalp (fig. 5). This had entirely disappeared on the following evening.

No pain in the trunk. No areas of tenderness except on the scalp.

[1] It is probable that I used more force and produced a greater effect on the nerves than a skilled operator would have done.

Parietal.

This area lies over the parietal eminence. The anterior border corresponds roughly with a line drawn vertically from the insertion of the one ear to that of the other. Its posterior border is roughly formed by a line making an angle of 45° with the vertical line from ear to ear. Thus, if the distance from the occipital protuberance to the root of the nose be from 13½ to 15 inches (34 to 38 cm.), the anterior limit of this area lies from 7 to 8½ inches (about 18 to 22 cm.) behind the root of the nose, and the posterior border about 3¼ to 4 inches (9 to 10 cm.) above the occipital protuberance. It extends downwards towards the upper part of the ear and occasionally seems to involve its extreme upper portion (fig. 6).

Its maximum point lies over the parietal eminence slightly to one side or other of the middle line.

When pain is present over this area the patient places his hand over the parietal eminence.

This area is occasionally affected in diseases of the ear, but never alone. Thus its anterior border can only be determined when its presence is due to disturbance of the lower part of the stomach or some similar visceral lesion.

Case 6.—Hebzibah C. (Victoria Park, Dr. Chaplin), aged 28.

When 1 year old she had measles and whooping cough. This left her with a slight cough. At 8 years old the cough became worse. Became steadily worse each winter, picking up again each summer. At 17 years "bronchitis and inflammation of the lungs." Repeated similar attacks ever since. She has been under Dr. Chaplin's observation for eight years.

Marked signs of fibroid phthisis on the right side. Chest retracted, lateral curvature. Bronchial breathing, bronchophony and large râles over the whole right side from top to bottom.

Respirations 40 in the minute. Pulse 72. Heart drawn completely over to the right side. No murmur.

The whole of the condition described so far is stationary. A few weeks ago she began to suffer from pain in the left side and increased shortness of breath. On admission, besides the stationary signs on the right side, some râles were heard at the left base.

She improved, but then had an increase of signs at the left base with increased shortness of breath.

She then complained of pain in the left side associated with

superficial tenderness over the eighth and ninth dorsal areas on the left side.

She also complained of parietal headache associated with the scalp tenderness shown in fig. 6.[1]

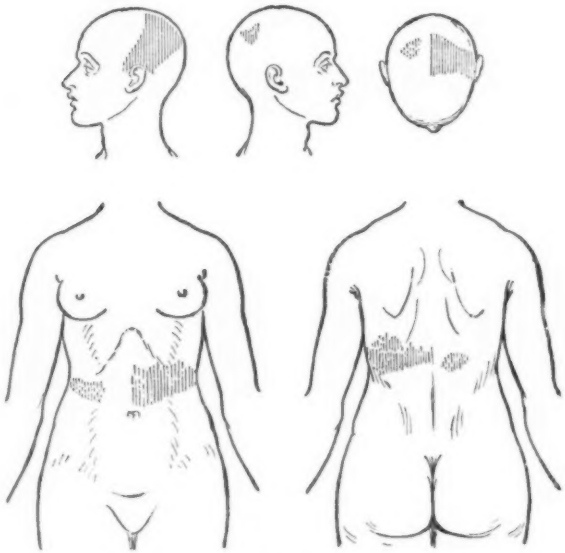


FIG. 6.

To show superficial tenderness over the parietal area of the scalp. On the left side the maximum only is present. From Case No. 6. On the left side of the body the ninth and part of the eighth dorsal areas are affected. On the right side of the body the maxima of the ninth dorsal only were tender.

Occipital.

This area lies in the gap between the posterior border of the parietal area in front of it, and the occipital protuberance. It is roughly oval extending for almost 2 inches (5 cm.) to the right or left of the middle line (fig. 7).

The maximum of this area lies just above the occipital protuberance, and a little to one or other side of the middle line.

[1] This case will be fully reported in my paper on the "Mental Changes in Visceral Disease."

When this area is affected the patient complains of pain over the upper part of the occipital protuberance just above the horizontal level of the ears.

Pain over this area is practically always referred from the abdomen excepting in those rare instances where it is associated with lesions of the posterior part of the dorsum of the tongue.

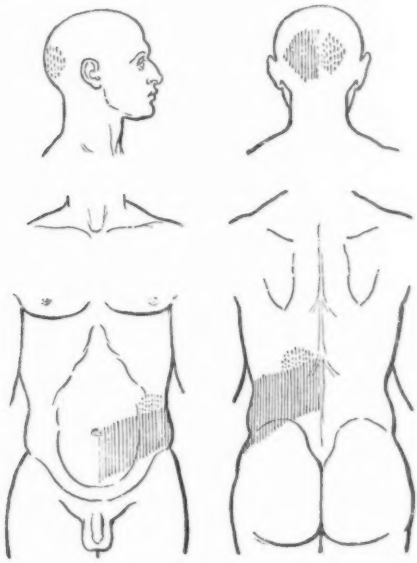


FIG. 7.

To show tenderness of the scalp involving the occipital area (Case No. 7). On the left side of the abdomen and in the left loin the tenth dorsal area is present together with the two maxima of the ninth dorsal area.

Case 7.—Ernest P. (Victoria Park, Dr. Thorowgood), aged 23.

April 21, began to feel very ill, and had pain in the left loin. April 22, he seemed so ill that he was admitted at once.

He is a finely-built, athletic man.

Tongue coated with white fur. Bowels not opened since April 20. No vomiting. Felt sick, April 21 and 22.

No physical signs in abdomen. Spleen not felt. Splenic dulness not increased.

No abnormal physical signs in heart or lungs. Pulse 68,

regular, good stroke and tension. Respiration 10 to 12 in the minute. No dyspnœa.

He complained of pain in the left iliac fossa and left loin. Marked superficial tenderness over the area of the tenth dorsal segment on the left side.

Headache "at the back of the head" with superficial tenderness in the occipital region as in fig. 7.

Under the influence of calomel and saline purgatives his bowels became regular, pain and tenderness disappeared, and he was well by April 28.

Rostral.

Seven areas have now been mapped out on the dorsal part of the head. Before passing on to the remaining areas of the face and neck one other area of this group deserves notice. In certain nasal affections we occasionally find that the skin on the front of the nose is tender. Occasionally also in disturbances of the thoracic viscera the bridge of the nose as far as the horizontal level of the alæ nasi seems to be affected. Now the downward flap of the fronto-nasal area does not meet the middle line on the bridge of the nose, but lies more over the lachrymal canal. Thus I cannot help thinking that in front of the fronto-nasal area lies an unimportant, almost rudimentary, patch which I shall call the rostral area.

Further evidence for the existence of this patch will be adduced later when I treat of herpetic eruptions of the face and forehead (p. 376).

B. *Lateral Areas.*

Maxillary.

This is a very easy area to define. It lies over the upper jaw extending as far forwards as the lateral fold between the nose and the cheek. Its upper border is formed by the lower margin of the bony orbit. Its lower border is a curved line joining a point on the cheek, close to the fold between the alæ nasi and the upper lip, with a point just posterior to the bony orbit. The apex of this area lies between the posterior border of the fronto-temporal, and the

anterior border of the temporal areas. At the level of the eyebrow the apex lies about 3 inches (7·5 cm.) from the middle line of the forehead (fig. 8).

To this area also belongs that part of the upper jaw which contains the bicuspid teeth, together with a portion of the hard palate. When it is affected from other causes than caries of these teeth (*e.g.*, lesions of the eye) these teeth may ache, and the hard palate in their neighbourhood may be tender.

If this area is affected the patient complains of pain over that part of the cheek which lies over the upper jaw.

This area is sometimes tender with iritis or with rise of tension in the vitreous chamber of the eye. It is, however, most commonly produced by caries of certain teeth of the upper jaw.

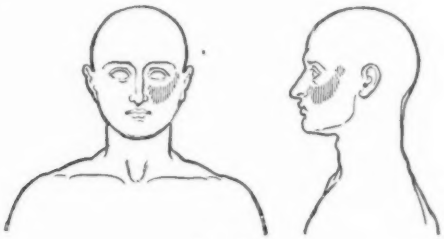


FIG. 8.

To show tenderness over the maxillary area of the face (Case No. 8). The tenderness was due to the first molar tooth of the upper jaw.

Case 8.—Thomas B. (National Dental Hospital).

Three weeks ago he suffered from great pain in the first molar tooth of the upper jaw on the left side. A dentist attempted to extract the tooth, but broke off the crown.

Ever since he has had gnawing pain in the position of the tooth, with pain in the left cheek. The left cheek feels sore whenever he touches it. The roof of the mouth on the affected side also feels sore.

Superficial tenderness over the cheek as in fig. 8.

Both roots can be felt in the socket, and are intensely tender to the point of the probe.

The eye is normal. No pain in the ear or tongue.

Otherwise a perfectly healthy young man. No pain elsewhere in the body.

After extraction the tooth was found to have been broken below the crown. The nerve in the roots was exposed, living and reddened. No periodontitis.

All pain and tenderness disappeared after removal of the tooth.

Mandibular.

This area is also roughly triangular and lies over the coronoid process, the ramus, and part of the body of the lower jaw. Below, it extends as far forwards as a line dropped vertically from the external canthus of the eye. The apex of the triangle lies about ½ inch (1 cm.) in front of the insertion of the ear. From this point the posterior border dips back to include the tragus of the ear, and then swings forwards and downwards in front of the posterior border of the lower jaw. The anterior border of this area abuts on the posterior border of the maxillary area except at its lower portion (fig. 9).

The maximum spot of this area lies about on a level with and a little in front of the tragus of the ear.

The pain of this area is referred to the cheek, just in front of the ear.

This area becomes tender with disease of the last two molars of the upper jaw.

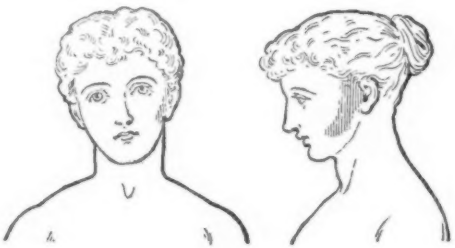


FIG. 9.

To show tenderness over the mandibular area of the face (Case No. 9). The tenderness was due to caries of the second molar tooth of the upper jaw.

Case 9.—Eliza P. (National Dental Hospital), aged 24.

She has suffered from pain, on and off, in the second molar on the left side of the upper jaw.

In addition to the pain in the tooth she has an aching pain in the face, mainly just in front of the ear.

Superficial tenderness as in fig. 9.

No pain in tongue or roof of mouth. No pain in the ear itself, but just in front of the ear.

Not anæmic. Typically healthy, red-faced girl. No pain after food. No vomiting. No pain with menstruation.

The second upper molar on left side reacts to the point of the probe. No other teeth react.

After extraction, the pulp chamber was found to be exposed and there was much sodden dentine. Living pink nerve in each root.

Hyoid.

This area lies partly over the ramus of the lower jaw, and partly behind its posterior border. Its limits are best gathered from fig. 10. Posteriorly it runs up on to the mastoid, and hence superficial tenderness over this area may give rise to fictitious "mastoid tenderness." The lobule of the ear is also tender. The anterior border of this area lies in front of the lobule, but does not include the tragus which belongs to the area in front (mandibular). When this area is affected the meatus, especially the posterior portion, is intensely tender and the insertion of an aural speculum will give much pain.

When this portion of the skin is tender there is also tenderness, as a rule, over the edge of the tongue. This strip on the tongue is about a centimetre in breadth, and comes forwards to within one to one and a half centimetres of the tip. (*Vide* p. 419.)

The maximum spot of this area on the surface of the head lies just behind, and below the angle of the lower jaw. A second most important maximum lies in the external auditory meatus.

The patient complains of pain in the ear ("earache"), and of pain "just behind the jaw." Hence arises the habitual complaint of pain in the ear with affections of the tonsils, side of the tongue, and molar teeth of the lower jaw. It also explains the pain in the ear so commonly met with in diphtheria.

This area is frequently present in affections of the ear,

tonsils, tongue and teeth, and it is one that is liable to lead to many errors in diagnosis. I have seen the membrana tympani perforated without relief, when the fault lay in the molars of the lower jaw. (*Vide* p. 417.)

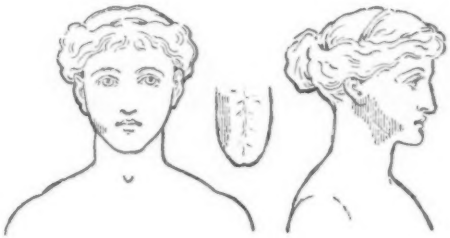


FIG. 10.

To show tenderness over the hyoid area of the face (Case No. 10). The tenderness was due to the first molar tooth of the lower jaw.

Case 10.—Fanny T. (National Dental Hospital), aged 30.

She complains of sharp pain in the ear and under the right jaw. The back of the jaw aches, and the lobule of the ear has become so tender that she has been obliged to remove the ear-ring. She also complains that the right edge of the tongue is sore.

Definite superficial tenderness as in fig. 10.

The first molar on the right side of the lower jaw reacts to the point of the probe. No other teeth react.

No pain elsewhere in the head and body. No pain after food.

Is not anæmic.

After extraction the pulp cavity was found to be fully exposed. The pulp in the crown was dead, but there was a living reddened nerve in each root. No periodontitis.

A week afterwards she was found to be absolutely free from pain and tenderness.

Superior Laryngeal.

Below the hyoid area we come on to a territory of skin that is exceedingly hard to map out. For the proportions of the front of the neck between the jaw and the sternum

vary very greatly. Thus the nature of any area in this region depends on its relation to the surrounding skin rather than on actual measurements in inches from bony points. Moreover the skin of the neck is less sensitive than that of the face to all sensory stimuli.

The area next below the hyoid is roughly triangular in shape. The apex of the triangle reaches posteriorly to the level of a line dropped vertically from the posterior attachment of the ear. The posterior part of its lower border lies just behind the anterior border of the sterno-mastoid, and thence swings downwards and forwards to the level of the lower part of the thyroid cartilage. The upper border runs forwards from the posterior angle, and just laps up on to the extreme posterior border of the body of the lower jaw. It then skirts the fold between the chin and the neck, and seems to meet its fellow of the other side in about the thyro-hyoid space. From this anterior superior angle the base of the triangle curves downwards to meet the termination of the lower border a little to one side of the middle line at the level of the lower border of the thyroid cartilage. Thus, although of smaller size, this area is seen to bear a curious resemblance to the hyoid area in shape (fig. 11).

I pointed out that the hyoid area supplied the sides of the tongue. In the same way I believe the superior laryngeal area supplies the dorsum as far forwards as about 3 cm. from the tip.

The maximum point of this area lies just in front of the anterior border of the sterno-mastoid at the level of the pomum adami.

If this area is affected from any cause whatever the patient complains that he has difficulty in swallowing.

The pain is said to lie " in the throat," and the patient points to the situation of the maximum spot.

Though anatomically a small area, and one that has been crowded in the course of development, it is still functionally important. For into it refer the wisdom teeth of the lower jaw, and the posterior part of the dorsum of the tongue.

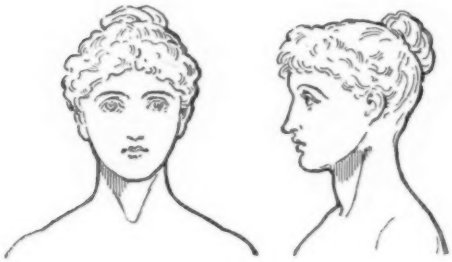


FIG. 11.

To show tenderness over the superior laryngeal area of the neck (Case 11). The tenderness was due to the wisdom tooth of the lower jaw.

Case 11.—Annie B. (National Dental Hospital), aged 20.

She complains of pain in the wisdom tooth on the right side of the lower jaw.

She also complains of pain shooting down the anterior border of the sterno-mastoid "into the throat."

Superficial tenderness as in fig. 11.

No pain elsewhere. No headache. No pain after food.

No pain in the ear.

The wisdom tooth reacts to the point of the probe. No other teeth react.

After extraction the pulp was found to be exposed by a cavity infiltrating the whole crown of the tooth. Pulp reddened, but living. No periodontitis.

Inferior Laryngeal.

In this area the tendency to elongation downwards, which was manifest in the superior laryngeal, becomes still more striking. The superior angle lies on the anterior border of the sterno-mastoid at about the level of the pomum adami. The upper border runs with a slight curve almost directly inwards to reach the middle line at about the crico-thyroid membrane. The posterior border runs along the anterior border of the sterno-mastoid to the sterno-clavicular articulation. It then bends a little outwards, forming a small patch over the sterno-clavicular joint. The base of the triangle is formed by the middle line (fig. 12).

The maximum point of this area lies over the anterior border of the sterno-mastoid muscle a little below the level of the cricoid cartilage.

This area becomes tender in diseases of the larynx, especially such as affect the vocal cords and parts below them. The pain is said to be situated over the anterior border of the sterno-mastoid at about the level of the cricoid cartilage. If this area is tender the patient complains that he has a feeling as if there was something in his throat, and thus the so-called "globus," in one or another form, may be a symptom of grave organic disease of the larynx.

Moreover, stimulation over this tender area will cause a feeling of tickling in the throat and thus frequently produce a reflex cough.

FIG. 12.

To show tenderness over the inferior laryngeal areas of the neck (Case No. 12). The tenderness was due to ulceration of the larynx.

Case 12.—George G. (Victoria Park, Dr. Thorowgood), aged 42.

As a young man he suffered from cough and once spat blood. At 30 he had another attack in connection with a "cold." Sweated at night and wasted. Recovered and remained fairly well till November, 1892. He then "caught a cold," had a troublesome cough, and two weeks later lost his voice. Has been ill ever since, recovering a little with the warm weather, but becoming worse again with the winter.

October, 1893.—*Condition of Larynx.*—Epiglottis reddened, slightly swelled and quite immovable. Arytenoid mucous membrane swollen and œdematous. On the right arytenoid is a superficial ulcer. Left ventricular band ulcerated longitudinally, with a yellowish slough.

He complains of pain and soreness over the neck between the anterior borders of the two sterno-mastoids.

Marked superficial tenderness over the areas in fig. 12.

There were signs of consolidation at both apices and at the left base, but throughout the two months he was under observation the destructive changes in the lungs advanced very slowly.

On the other hand the destruction of the larynx advanced rapidly, and he repeatedly suffered from pain in the throat associated with cutaneous tenderness over the superior and inferior laryngeal areas. I have selected an occasion on which the inferior laryngeal area was mainly affected. Whenever this area of tenderness was present a cough could be excited by stimulating the tender skin.

Died November 30.

Post-mortem.—The larynx was much ulcerated. The base of the epiglottis was thickened and ulcerated. The whole of the left cord was practically destroyed. The right was ulcerated but not to the same extent, and appeared reddened even after death. The arytenoid cartilages were ulcerated and nearly destroyed. There was an ulcer in the trachea.

It was a typical case of tubercular ulceration of the larynx.

This is the lowest of the areas into which reference takes place directly from organs in the head or neck.

But before passing on to the two areas on the lateral aspect of the neck, I must return to two areas on the face which I have so far neglected.

C. *Anterior Areas of the Face.*

Naso-labial.

This area lies over the upper lip, tip and under surface of of the nose, and on the cheek. It includes part of the lower lip and extends, as a patch on the cheek, as far back as a line dropped vertically from the external canthus of the eye. It is exceedingly difficult to describe in words, and can best be understood from fig. 13. It is not easy to mark out the limits of this area except in some cases of caries of the teeth.

When present, the patient complains that his upper lip is "swollen and tender" and that the "tip of the nose is sore."

This area is associated with lesions of the respiratory portions of the nose, but under such circumstances is mostly

accompanied by the rostral, and frequently by the fronto-nasal areas. With caries of the teeth it may, however, appear alone.

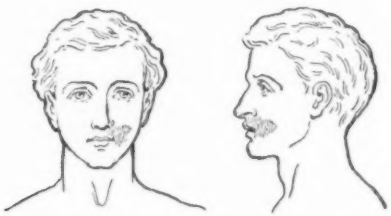


FIG. 13.

To show tenderness over the naso-labial area of the face (Case No. 13). The tenderness was due to the canine of the upper jaw.

Case 13.—Stephen R. (National Dental Hospital), aged 21.

He complains of pain in the left upper canine and of pain in the face a little behind and above the level of the angle of the mouth.

Superficial tenderness as in fig. 13.

The tongue is not sore. Roof of mouth not sore.

Left upper canine reacts to the point of the probe. No other teeth react.

The canine was drilled and a living nerve was killed with an arsenical dressing. Later the tooth was stopped and all pain disappeared.

Mental.

This area swings almost directly back from the angle of the mouth to a point in a line drawn vertically downwards from the external canthus of the eye. Thence it drops slowly to a point on the posterior border of the body of the lower jaw, about 2½ to 3 inches (6 to 7·5 cm.) from the middle line. It then runs forwards along the fold separating the chin from the neck. In front it does not include the lower lip or that part above the elevation of the chin (fig. 14).

When this area is affected the anterior 3 cm. of the tongue are tender, on the side affected.

The maximum point of this area lies close to a vertical line dropped from the angle of the mouth.

The pain is said to be situated over a point on the lower jaw close to a vertical line drawn downwards from the angle of the mouth. This point lies close to the point where the mental nerve enters the superficial structures from below.

This area is tender in connection with disease of the anterior part of the tongue and of the incisor and canine teeth of the lower jaw.

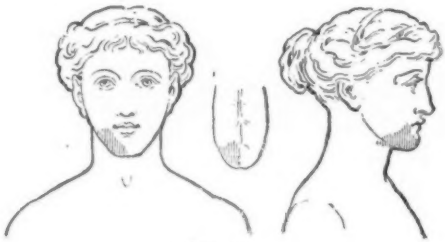


FIG. 14.

To show tenderness over the mental area of the face (Case No. 14). The tenderness was due to the canine of the lower jaw.

Case 14.—Ada C. (National Dental Hospital), aged 30.

For ten days she has suffered from pain in front of the lower jaw. She points to a spot just below the angle of the mouth on the right side. The tip of the tongue is sore. Pain in right lower canine.

Marked tenderness of the face and of the right side of the tip of the tongue as in fig. 14.

The canine on the right side of the lower jaw reacts to the probe.

No pain elsewhere in body or head. Tongue normal, excepting for the tenderness of the right side of the tip, for which there is no obvious cause in the tongue itself.

After extraction the root was found to contain a living reddened nerve. There was a mass of sodden dentine over the exposure. No periodontitis.

Thus I have now described a series of dorsal areas, a series of lateral areas, and two areas on the anterior aspect of the face. Below the mental area there are no anterior areas, and the homologous portions in the neck seem to have doubled inwards and to appear on the tongue.

D. *The Areas of Neck.*

Sterno-mastoid.

The upper portion of this area lies behind the ear and over the insertion of the sterno-mastoid muscle, into the occipital bone, at the superior curved line. The descending portion of the area lies over the sterno-mastoid and almost exactly follows the anterior border of this muscle. On the front of the chest it reaches the upper border of the second rib. It covers the inner third of the clavicle and the supra-clavicular fossa. The posterior border of this area swings away from the occiput, rapidly joining the anterior border of the upper part of the trapezius (cucullaris) muscle to end on the shoulder close to the inner and anterior aspect of the shoulder joint. The lower border then rises again to a point above the clavicle in the outer part of the supra-clavicular fossa. In this way a notch is formed between the anterior angle, which is pulled down on to the chest, and the posterior angle, which is pulled down over the outer part of the clavicle. This area can clinically be quickly differentiated from the next area below it by its large basi-occipital flap and from the fact that except for this extreme upper part none of its territory can be seen from behind (fig. 15).

One well-marked maximum lies over the hollow between the insertion of the trapezius (cucullaris) and of the sterno-mastoid into the skull. A second maximum lies over the supra-clavicular fossa.

The pain of this area is said to be an aching "over the neck and back of the head" or is called "a stiff neck."

This area is not primarily tender in disease of any organ of the head or neck. But it is a very important area in connection with pain due to disturbances of organs in the chest.

Case 15.—Joseph C. (Victoria Park, Dr. Lyon), aged 30.
Was quite well till three years ago, when he "caught cold after cold." Since then has never been quite free from cough. Sputum occasionally tinged with blood; not profuse. Has sweated at night for two years. Has been wasting for seven to eight weeks.

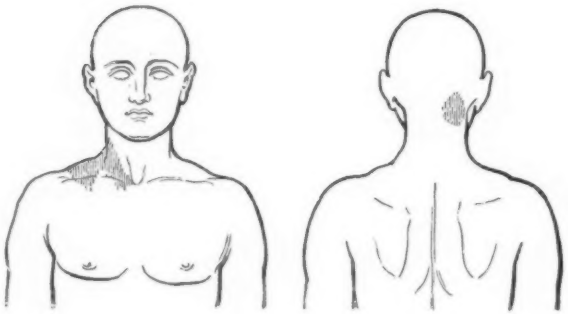


FIG. 15.

To show tenderness over the sterno-mastoid area of the neck (Case No. 15). The tenderness was due to tubercular disease at the apex of the right lung (acute outburst).

September 18.—Condition as follows :—

Cough not very troublesome. Respiration 36. Short of breath on exertion. Sputum muco-purulent, not profuse ; no blood.

Diminished movement, and higher pitched note under right clavicle. Over right apex expiration prolonged with whispered bronchophony. Behind, over right apex, diminished percussion note ; expiration prolonged. Fine crackling râles heard over right apex both back and front, and in supra-clavicular fossa.

Over the left side percussion note was good. Breath sounds possibly a little weak over left apex. A few crackling râles heard.

Pulse 88. Heart sounds normal.

He was free from pain and tenderness.

He improved somewhat ; gained 2lb. Temperature ranged from 100° F. (37·8° C.) at night to 98° (36·7° C.) in the morning.

On November 15, he woke with a sharp pain over the right shoulder. (Examination of the right shoulder revealed no physical abnormality.)

The next day he complained of an aching feeling "as if he was bruised" over the right supra-clavicular fossa, and right side of the neck. This lasted for a week, and was associated with the superficial tenderness shown in fig. 15. Sometimes this tenderness diminished to a spot, sometimes it was present as a full area.

On November 15 and 16 the temperature did not fall below 99° F. (37·2° C.), and rose on the 16th to 101·2° F. (38·5° C.) He began to sweat profusely and ceased gaining weight.

From this time râles were heard over the right back as low as

the angle of the scapula, and the signs at the right apex in front became more active.

When he left the hospital on December 10 he had lost 2½lb. His temperature was ranging from 101° F. (38·3° C.) to 98° F. (36·6° C.) in the 24 hours. His shoulder was still painful at times. The signs were evidently increasing over the upper part of the right lung. The left apex was quiet.

Thus I cannot help thinking that the pain and tenderness shown in fig. 15 were due to a sudden increase in the activity of the destructive changes at the right apex dating from November 15.

Sterno-nuchal.

The dorsal border of this area occupies from about the fourth to the seventh cervical spines. From about the seventh cervical spine, its lower border runs outwards and downwards to the spine of the scapula and covers the upper part of the trapezius (cucullaris) muscle. It sends a flap downwards over the posterior aspect of the shoulder joint and then swings over the shoulder, in the region of the acromion. From the tip of the acromion it dips sharply downwards into the groove between the deltoid and the clavicular portion of the pectoralis. It descends on the arm to the level of the lower border of the pectoralis, and then rises to the front of the shoulder joint, to end on the front of the chest over the third rib (fig. 16).

The pain of this area is said to lie over the shoulder joint, both in front and behind, and occasionally pain is produced when the patient moves his arm on the shoulder. No pain is however produced by gentle passive movement at the shoulder joint.

This area of tenderness appears solely in answer to disturbances in the thorax and abdomen, and is not affected by lesions of any organ of the head and neck.

Case 16.—James C. (Victoria Park, Dr. Thorowgood), aged 43, sawdust dealer.

He has had many accidents in the course of his work.

June, 1893.—Became short of breath with a slight cough, went to Guy's Hospital where clear fluid was removed from his chest.

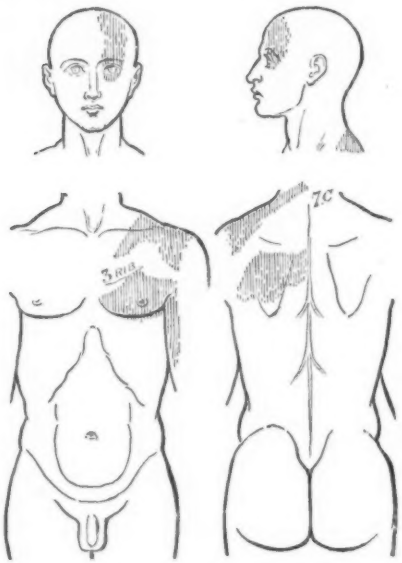


FIG. 16.

To show tenderness over the sterno-nuchal area of the neck (Case No. 16). This fig. also shows tenderness over the third and fourth dorsal areas on the chest and over the mid-orbital and fronto-temporal areas of the scalp on the left side (chap. iii.). Compare with this, fig. 45, p. 432.

On discharge felt well until he tried to work. He then found that the pains in the left side, of which he had complained on and off for some time before admission to the hospital, were as bad as ever.

Alcohol four to six half-pints daily. Denies gonorrhœa and syphilis. Married.

On admission (*December*, 1893), he was well nourished. Largely built man. Very intelligent.

Respiration 17. Slight single occasional cough.

Some pain above left nipple darting through to scapula behind. Definite superficial tenderness, which I shall describe in a subsequent paper.[1]

Pulse 76, regular. The right pulse is stronger than the left all up the arm.

Apex beat fifth space one inch outside nipple line. No pulsation elsewhere in the chest. No thrill; suspicion of dulness on

[1] Part iii. of this investigation.

percussion over upper part of sternum at level of second rib. Cardiac dulness otherwise a little diminished. Loud systolic murmur over upper part of sternum and second right intercostal space sometimes conducted to apex, but not heard in the axilla. Murmur heard in arteries of the neck. No diastolic murmur, second sound heard over second right interspace; second sound over apex beat good, first sound sharp, full toned.

Signs of an old pleurisy at the right base. Slight emphysema but otherwise no abnormal signs in the lungs. Larynx normal.

Tongue clean. Bowels confined. Appetite good; no pain after food. Liver not enlarged.

Whilst in the hospital he gradually lost the pain and tenderness, put on weight, and went out January 20, much improved.

He began to work at the end of March, 1894, and I saw him on April 10, with all the pain and tenderness back again over the areas in fig. 16.

Physical signs in the chest exactly as before. Pulse 80, small stroke, not regurgitant. Signs at the base of the right lung exactly as before. Nothing in the abdomen.

The sterno-nuchal is the last of the areas on the neck which are tender from visceral disease. The next area below, that appears in consequence of visceral disease, is the dorso-ulnar or area of the first dorsal segment. Thus, as I showed in my first paper, the upper gap, into which no direct reference takes place, lies between the sterno-nuchal above and the first dorsal area below.

§ 2. *Herpetic Eruptions of the Head and Neck.*

When discussing the areas of tenderness on the body I pointed out that they resembled the distribution of herpes zoster. As each tender area was described, an instance was given to show the corresponding distribution of an herpetic eruption. Thus zoster formed an interesting corroboration of the existence of areas having the likeness and form of the hyperalgesic zones I had described.

On the neck and shoulders herpes still follows the lines laid down in the first half of this chapter. On the forehead and scalp I do not think that these lines are transgressed, but there is a greater tendency for the areas to appear in groups than is the case on the body. On the face this tendency is exaggerated, and in many cases it would appear

at first sight as if the lines laid down from the study of the tenderness in visceral disease were set at naught. I shall, however, try and show that, if a considerable number of cases are examined and carefully drawn, some order seems to appear in the apparent chaos.

The results detailed in this section are based on 78 cases of herpes on the body and limbs, 19 cases on the neck and shoulder, 11 cases on the scalp, and 45 selected cases on the face, collected and drawn by myself.

Herpes of the Scalp and Forehead.

The fronto-nasal area is not uncommonly mapped out by herpes, but it mostly occurs with one of its neighbours. Fig. 17 shows this area in a case where the nasal portion was not covered by the eruption but was intensely tender. When this area is affected by herpes a shallow ulcer is very liable to appear on the cornea.

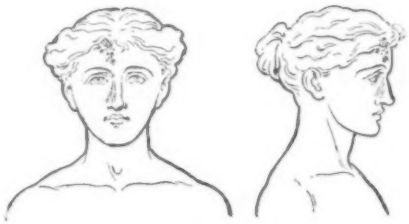


FIG. 17.

To show the distribution of an herpetic eruption over the upper part of the fronto-nasal area (Case No. 17). The dotted area on the forehead represents the eruption. The shaded area on the nose was intensely tender but was not covered with vesicles (*cf.* fig. 1).

Case 17.—Annie R., aged 20. October, 1891.

Three days ago eruption began to come out, and "the forehead ached like fire;" last night upper eyelid swelled. Nose swelled and became tender.

The eruption follows the area in fig. 17. There is great tenderness to the head of a pin over the shaded areas on the nose.

Slight conjunctivitis. Eye has watered for the last two days. No ulcer on cornea.

Last lower molar decayed. No other bad teeth.

The next figure (fig. 18) shows an eruption that occupied the mid-orbital and fronto-temporal areas in addition to those in front. The posterior limit of the eruption was $2\frac{1}{4}$ inches (5·5 cm.) from the vertical line joining one ear with the other.

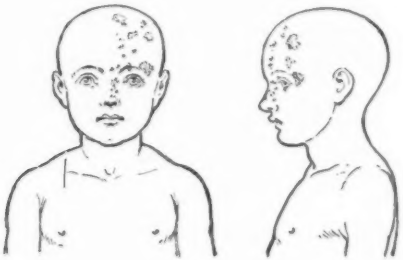


FIG. 18.

To show an herpetic eruption occupying the rostral, fronto-nasal, mid-orbital and fronto-temporal areas (Case No. 18).

ase 18.—Hannah P., aged 6. January, 1893.

January 8. She was a little hot and thirsty. Thought to be "feverish," and was given a "cooling powder."

January 9. A few spots appeared over the forehead, just below the border of the hair.

January 10. The left eye began to swell, and the eruption came out on the temple. She vomited two or three times in the morning and again in the afternoon.

January 11. Admitted to the eye ward under Mr. Tweedy. Weakly looking child.

Very marked herpes of the forehead; the vesicles are large, and several of them have raised, inflamed edges. The largest is situated on the outer part of the eyebrow. There is some swelling and œdema of the anterior part of the scalp. Both lids much swollen and œdematous. A large vesicle is situated over the margin of the upper lid at about its centre, and overlaps on to the conjunctival surface.

Conjunctiva reddened and injected. Cornea clear. No ulcer. Iris clear, dilates well under atropine.

The gland close to the lobule of the left ear is enlarged.

January 14. A tiny roughened pit is present on the outer edge of the left corneo-scleral margin.

Occasionally the complete distribution of the first or ophthalmic division of the fifth may be marked out by herpes. I give a case (fig. 19) in which the eruption closely corresponded to the distribution of the ophthalmic division of the fifth as determined by Sherrington and myself. (*Vide* chap. v.)

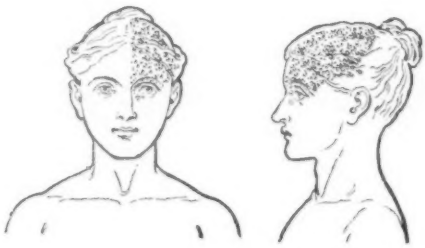


FIG. 19.

To show an herpetic eruption occupying the greater part of the fronto-nasal, mid-orbital, fronto-temporal, temporal and vertical areas (Case No. 19). The distribution of this eruption closely resembles the supply of the superior (ophthalmic) division of the fifth nerve.

Case 19.—Hannah D. (Royal Free Hospital, Dr. Sainsbury), aged 43.

October 22. She began to suffer from pain up the nose, over the left eyelid and on left side of scalp. "As if very strong sticking-plaster were dragging the flesh from the bone."

October 24. Two small spots came out on upper part of forehead.

October 26. Eruption came out all over the area in fig 19.

October 27. She was admitted into hospital. Well-marked herpetic vesicles over the area in the figure.

Chemosis. Tiny elevated spot at outer corneo-scleral border. Lower lid much swollen.

Distinct slight iritis.

Left optic disc red and injected, like that frequently seen with hypermetropia. Inner and lower edge cannot be clearly defined.

Right disc normal. Differs markedly from the left disc. No error of refraction in either eye.

Temperature.—October 27: Morning, 98·4° F. (36·9° C.); evening, 101° F. (38·3° C.). October 28: Morning, 98·2°; evening, 100·8°. October 29: Morning, 98·°; evening, 98·8. After this the temperature did not rise above normal.

It will be remembered that when speaking of the areas of hyperalgesia on the nose I pointed out that if the fronto-nasal area be drawn on both sides of the forehead, a portion of the nose remains unaffected between the two descending nasal limbs. Now this area is never affected alone in any case of referred pain and tenderness. But in some cases of disease of the nose, and in certain cases of tenderness associated with disturbances of the thoracic viscera, this gap seems to be filled in. I was therefore forced to conclude that this patch on the front of the nose formed the extreme anterior portion of the dorsal areas of the scalp.

Now in many cases of frontal herpes the whole of the nose to the middle line is covered by the eruption excepting over the ala nasi, and under surface of the tip (fig. 18). Thus here again we see signs of the presence of a rostral area.

I have no case showing the temporal area alone affected, but I give one (fig. 20) in which this area appeared with herpes around the upper lip.

FIG. 20.

To show an herpetic eruption over the temporal and naso-labial areas (Case No. 20).

Case 20.—George M. (U.C.H., Mr. Barker), aged 55. He was admitted November 1, 1892, for urethro-rectal fistula. Bougie passed occasionally.

November 13. No. 7 French bougie passed without difficulty. Followed by rigor. Temperature rose to 102·8 F. (39·3° C.). In the evening sudden pain in left leg below the knee. No pulsation

felt in dorsalis pedis, posterior tibial or popliteal arteries of left leg.

November 17. Herpes came out over the temporal region and around the mouth (fig. 20).

This case is published in full by Mr. Barker in the *Bristol Med. Chir. Journal*, June, 1893.

Herpes of the Neck and Arm.

Those forms of herpes which follow the areas on the front of the neck are mostly double. Fig. 21 shows the superior laryngeal area on the left side, and the superior and inferior laryngeal areas on the right side.

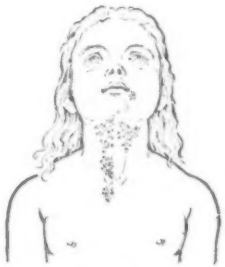


FIG. 21.

To show the distribution of the herpetic eruption in Case No. 21. On the right side the eruption occupied the superior and inferior laryngeal areas; on the left side the superior laryngeal area was affected (*cf.* figs. 11 and 12).

Case 21.—Rose C., aged 6.

June 9 she seemed ill. She complained that her throat was very sore and ate hardly anything. She was very hot at night.

June 10 vomited. Still took nothing to eat. Complaining that her throat was sore. At three p.m. the eruption began to come out.

June 15. The eruption follows the lines in fig 21.

She has a curious cough somewhat resembling whooping cough. Signs of bronchitis and emphysema in the chest.

The next area is the sterno-mastoid, shown in fig. 22. All its characteristic points are well marked; the large sub-occipital flap, the outer part over the shoulder, and the inner part over the supra-clavicular fossa are all well shown. It is noteworthy that this area always sends a small

anterior portion to a point on the cheek just below the ear. This anterior flap is too small to be recognised clinically in the corresponding area of tenderness, but I cannot help thinking that I have more than once detected signs of its presence in cases of phthisis.

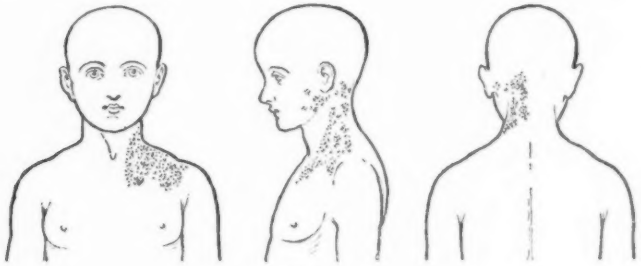


FIG. 22.

To show an herpetic eruption occupying the sterno-mastoid area (Case No. 22). Compare fig. 15 and fig. 53.

Case 22.—Daisy B., aged 6, October 24, 1891.

For some days she has been complaining of pain extending from the left ear into the neck. To-day the first spot of herpes came out over the first intercostal space and second rib.

October 25, the spot in the supra-clavicular fossa appeared.

October 27, the eruption came out fully.

No cough. No signs in lungs. Appetite good. Bowels open daily.

Next below the sterno-mastoid comes the sterno-nuchal area (fig. 23).

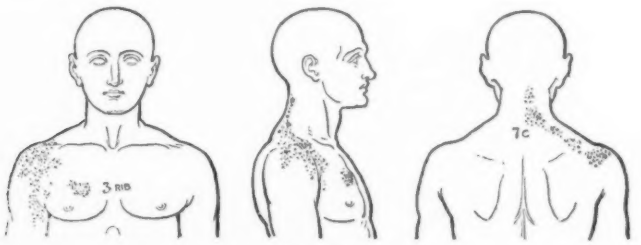


FIG. 23.

To show an herpetic eruption occupying the sterno-nuchal area (Case No. 23). Compare fig. 16.

Case 23.—Francis W., aged 20.

June 21, 1891. He felt a burning pain in his left shoulder, and the eruption began to come out over the posterior aspect of the shoulder joint. The advent of the eruption was not preceded by pain for any length of time.

The spot on the chest came out on June 24.

No cough. No physical signs in the chest. Bowels regular. Appetite good.

These two areas are particularly prone to occur together and occasionally the eruption occupies in addition the superior and inferior laryngeal areas.

We have now reached the limit of the areas over which tenderness is present with referred pain. Thus the upper gap, occupying the greater part of the arm, would be *terra incognita* but for herpetic eruptions. For whilst the lower gap, situated over the leg, could be approximately filled in by the study of organic lesions of the spinal cord, such lesions are, owing to their fatal nature, too rare to enable us to fill in the gap on the arm.

Herpes of the upper limb is rare and frequently imperfect. But in the course of three years I have succeeded in collecting an almost complete series of cases. The one missing area in my series is supplied by a case reported by Pfeiffer. By a complete series I mean cases in which what I take to be one area has appeared alone. Thus I assume that many of the remaining cases in my possession represent eruptions that occupied more than one area and it may turn out on further study that the cases I have selected as representing single areas in reality are more or less incomplete eruptions. This time alone can decide.

The first area below the sterno-nuchal is still attached to the spine, but the lateral portion is much pulled out so that it reaches the front of the elbow on the radial side. It no longer runs up to the middle line of the chest (fig. 24).

Case 24.—Sophia M., aged 49.

The eruption came out October 19, 1891. She had no pain except when the eruption was actually coming out. Since it has come out she has had an aching pain over the deltoid. It hurts her to raise her arm.

The extent of the eruption is shown in fig. 24.

No pain on breathing or coughing. No signs in chest. No cough. Appetite fair. Bowels opened daily.

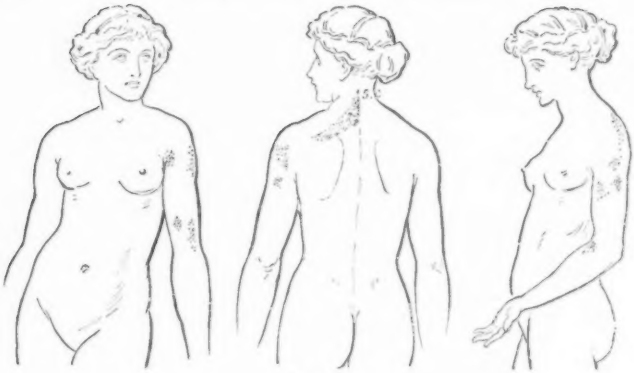


FIG. 24.

To show an herpetic eruption occupying the area of the fifth cervical segment (Case No. 24). This shows the first area of the upper gap.

The second area of the gap is still attached to the spine, but its anterior limb runs down the arm and forearm on the anterior surface to a point just above the wrist. The anterior angle of the first area of the gap just reached the anterior axillary fold. But the anterior angle of the second area lies to the radial side of the anterior axillary fold (fig. 25).

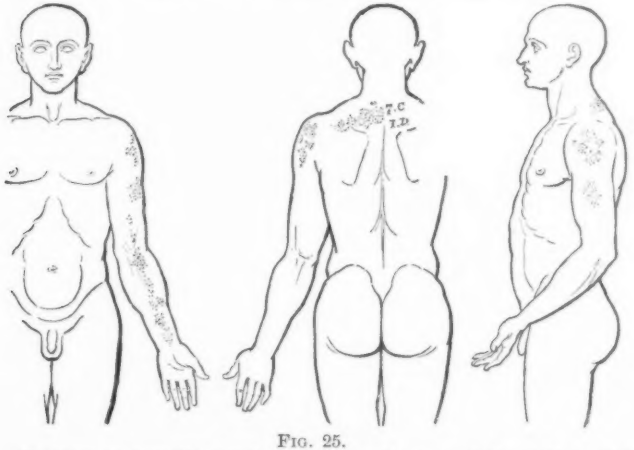


FIG. 25.

To show an herpetic eruption occupying the area of the sixth cervical segment (Case No. 25). This shows the second area of the upper gap.

Case 25.—Mr. Y., aged 21. Student of law. (Dr. Edmonds.)
December 9, he was feverish, hot, thirsty. Lassitude and disinclination to work.
December 10. Eruption came out.
He had no pain until just before the eruption came out (fig. 25).
No vomiting. No cough. No signs in chest. Bowels opened daily.

The third area has lost all connection with the spine behind or with the chest in front and occupies the radial side of the forearm anteriorly. If the arm is straightened and the hand placed with the ulnar border against the body and the thumb turned out this area almost covers that part of the arm seen in side view. On the hand it occupies the thumb and thenar eminence, in front and posteriorly the thumb and index finger (fig. 26).

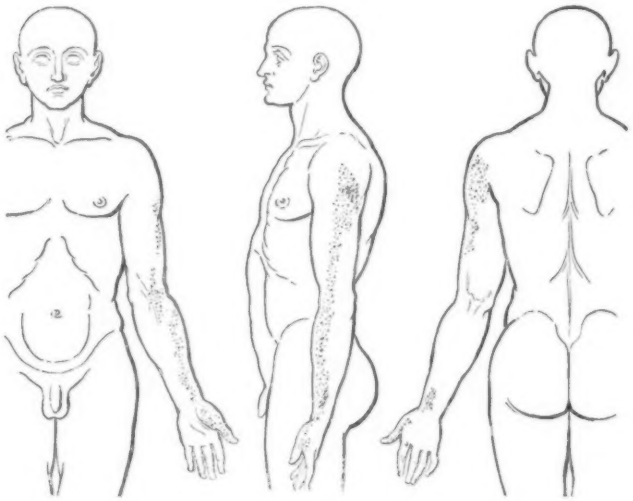


FIG. 26.

To show an herpetic eruption occupying the area of the seventh cervical segment (Case No. 26). This shows the third area of the upper gap.

Case 26.—Charles Henry E., aged 13.
May 10, 1893, he began to complain of pain down the radial side of the arm.

May 14, he became much worse. Vomited. Had been "hot and feverish" for a day or two, but this became worse and it was thought that he was sickening for the measles. He complained that he could not move his arm. He held it by the side and would not use it for anything.

May 17. Eruption came out (fig 26). The spot on the thenar eminence is covered with a large vesicle containing black fluid ("blood blister"). The top of the thumb is covered with confluent vesicles containing clear fluid.

He suffers from chronic cough. Slight diminution of percussion note over right apex behind. Bronchial breathing, increased vocal resonance and a few râles heard over right apex.

No obvious weakness of right arm. No paralysis of any muscle or movement. He complains, however, that movement is painful.

The fourth area lies mainly on the back of the arm and on the hand. It lies more to the ulnar side of the arm than the area I have just described. On the front of the forearm it swings from the radial side of the elbow to the ulnar side,

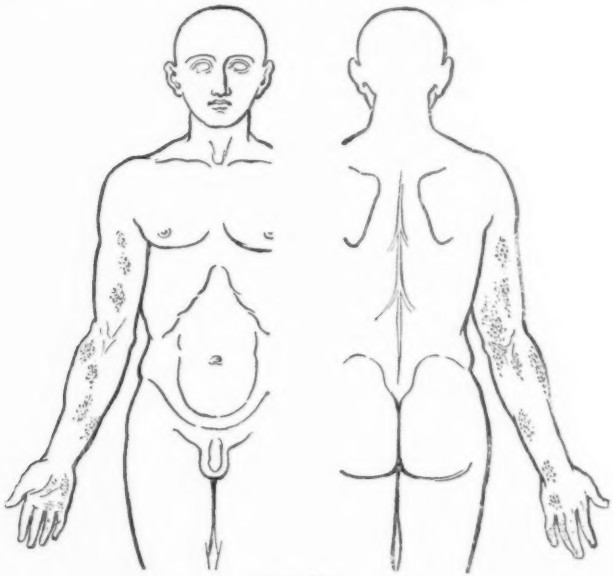


FIG. 27.

To show an eruption occupying what I believe to be the area of the eighth cervical segment. (Reproduced from Pfeiffer, *op. cit.*)

leaving the extreme ulnar border of the forearm and hand free. It occupies the palm of the hand, the ulnar side of the back of the hand and the whole of the ring finger. I believe it also affects the palmar surface of the index and middle fingers and the terminal two joints of the little finger.

I possess no pure case in my collection showing this area, though I have seen it in combination with the two areas below. I therefore give a reproduction of a figure by Pfeiffer.[1] Von Baerensprung[2] also figures a case which much resembles this area, although it seems to have extended somewhat further up the arm.

The next area below this is the highest of the series I described in my first paper. (Fig. 28 is a reproduction of fig. 12 in my first paper.)

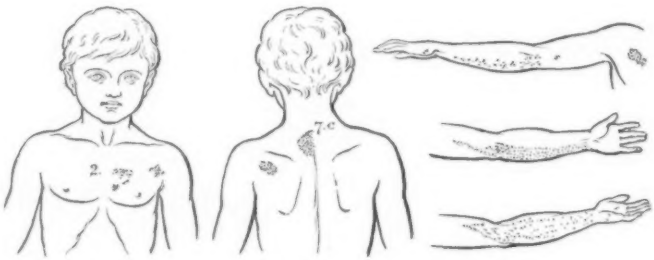


FIG. 28.

This is a reproduction of fig. 12 (Case No. 13) from my first paper (BRAIN, 1893, p. 33). It shows an herpetic eruption following the distribution of the first dorsal segment.

Now, if we accept the nomenclature I adopted in that paper,[3] this area belongs to the first dorsal segment. We can, therefore, count back as follows:—The fourth area of the gap (fig. 27) will represent the eighth cervical segment. The third area (fig. 26) will be the seventh cervical, the second the sixth cervical, and the first area of the gap will represent the fifth cervical segment of the cord. This makes the sterno-

[1] "Die Verbreitung des Herpes Zoster," Jena, 1889, Tafel vii.
[2] *Annalen des Charité Krankenhauses*, Bd. x., Heft 1, 1862, Tafel i.
[3] Thorburn's criticism of this nomenclature will be dealt with in Part ii.

nuchal the fourth cervical, and the sterno-mastoid the third cervical segmental areas of the cord.

Thus the gap on the arm appears to lie between the fourth cervical and the first dorsal segments.

Herpes of the Face.

The herpetic eruption on the lips that accompanies a cold or a febrile attack consists of small papules, which form scabs and fall off. It may occur time after time in the same position, is never widely spread, and in the character of its lesions does not resemble herpes zoster. If, however, a large number of cases of hereptic eruptions on the face are examined, we occasionally find cases in which the eruption assumes the typical vesicular form seen on the body. There are also some intermediate forms in which one portion may be truly vesicular and another portion may not have advanced beyond the papular stage. Now, whereas it is the rule to find that a patient has suffered several times from the "febrile" form (papular) of herpes, it is much less common (in my experience very uncommon) to find that a patient has had two attacks of the true vesicular form on the face.

Fig. 29 shows one of these cases in which the eruption was truly vesicular. The site of the eruption is that not uncommonly occupied by the papular form, but in this case the eruption consisted of large, clear vesicles on a reddened base, exactly like those on the body.

The resemblance that the distribution of this eruption bears to the tender area (naso-labial) shown in fig. 13 is noticeable.

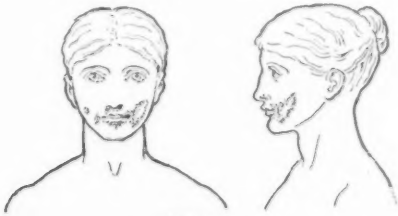


FIG. 29.

To show a true vesicular herpetic eruption occupying the naso-labial area of the face (Case No. 27). Compare fig. 13.

Case 27.—Mrs. W., aged 34.

January 21, 1892, she felt ill, shivering and cold, with aching pain in all her limbs. She has had a cough for some time, but it now became worse.

On the evening of January 23 she felt a burning and itching about the lips and around the mouth. In the night the eruption came out over the area in fig. 29. It consists of large and very marked vesicles on a reddened base, very different from the eruption usually seen around the lips. The tongue is not affected. No signs in lungs. Baby is one month old, and she is suckling it. No vomiting. Bowels confined for two days.

Another form of herpes on the face tends to affect the tip of the tongue, and resembles the mental area (fig. 14) in its distribution.

Thus, though many cases of so-called herpes of the lips do not resemble zoster, I cannot help thinking that the lips and lower jaw may be the seat of an eruption exactly analogous to zoster on the body or neck.

On the face herpes tends to follow curious lines. Thus the naso-labial, mental, superior and inferior laryngeal tend to appear in couples. The commonest arrangement is the naso-labial with the mental or the superior with the inferior laryngeal; but the superior laryngeal may be coupled with the mental. If two of these areas are affected, those which lie next one another tend to appear together, and I do not think the naso-labial appears with the superior or inferior laryngeal without the intervening mental area. In the same way the maxillary mandibular and hyoid areas may appear together.

Another form of combination is for the temporal area to appear with the maxillary or naso-labial areas; or for the mandibular to appear with the mental area; again the occipital may appear with the superior laryngeal.

But beyond these rough rules it is very difficult to foretell the distribution of a herpetic eruption on the face. There seems to be an extreme tendency to spread over the whole of that part of the face made up of the maxillary, naso-labial, mandibular, mental and temporal areas.

§ 3. *The form assumed by the Cervical Areas.*

The typical distribution of a spinal segment to the skin takes the form of a band running from the mid-dorsal to the mid-ventral line. But this simple arrangement is modified by the development of the arm. Passing from above downwards, the modification produced by the coming limb appears as high as the third cervical (sterno-mastoid) area. On the other hand amongst the areas of the trunk the arm makes its influence felt as low as the fifth thoracic (subscapulo-axillary). Thus at least ten areas are altered from the primitive band-like arrangement by the formation of the limb.

Thus although I have chosen the sterno-mastoid (cerv. 3) area as my type it must be borne in mind that this area already bears the impress of the coming limb. Fig. 30 shows this area reduced to a rough diagram. It may be described as having a dorsal limb, a ventral limb and a third limb, the lateral flap. The angle formed by the junction of the dorsal with the ventral limb may be called the cephalic[1] angle, and in the third cervical area is practically equal to two right angles. The lateral flap lies opposite the cephalic angle and is the first expression of the changes produced by the arm.

In the sterno-nuchal area the ventral limb is somewhat attenuated. The dorsal limb is still strongly developed and the lateral flap has just reached the arm in the neighbourhood of the bicipital groove.

The fifth cervical has lost its attachment to the chest, and the ventral limb is represented by a portion on the ulnar aspect of the upper arm. The summit or extreme ventral part of this limb is represented by a spot over the upper part of the anterior axillary fold. The dorsal limb is still of fair size, but is practically detached from the lateral flap. This lateral flap is much elongated and reaches the bend of the elbow. As the dorsal and ventral limbs approximate, the cephalic angle becomes more acute. Thus in the

[1] I choose this term in place of the more usual "anterior" to prevent confusion. For anterior to the comparative anatomist means nearer the head, to the human anatomist nearer the ventral surface of the body.

sterno-mastoid (third cervical) area it is practically two right angles, whilst in the fifth cervical it has become an acute angle.

With each successive area the anterior limb becomes smaller than the one above it, and in the sixth cervical area

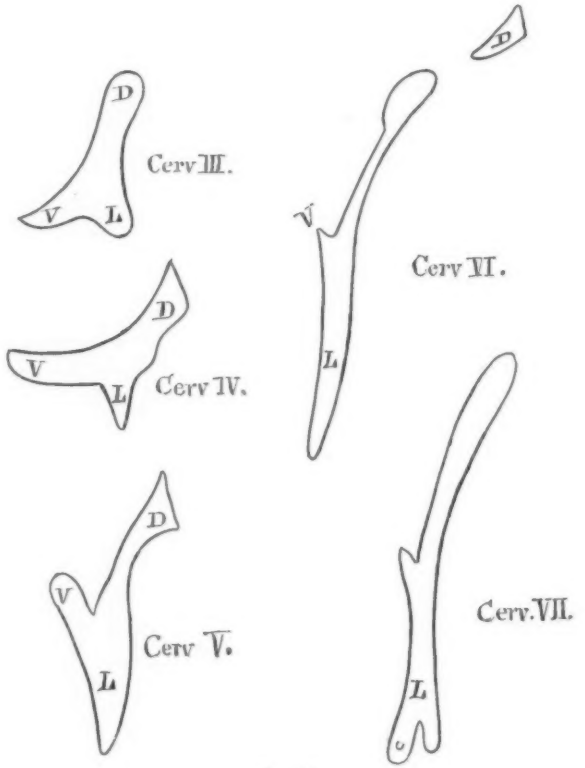


FIG. 30.

A series of diagrams to show the homologous parts of the areas from the third to the seventh cervical.

In each case D represents the dorsal, V the ventral portion of the primitive band-like area extending from dorsum to venter. L represents the lateral flap.

The seventh cervical area supplies the thumb and the posterior aspect of the index finger. The skin forming this area is therefore supposed to be stripped from the forearm and hand and spread out as a flat surface.

is reduced to a small tag. On the other hand the sixth cervical still has a dorsal limb of considerable size attached to the spine by a small dorsal flap. The greatest change, however, has taken place in the lateral flap, which is enlarged downwards and reaches the wrist.

The next area below, the seventh cervical, is no longer attached to the spine behind, but still has a considerable dorsal limb. The ventral limb is scarcely recognisable and the cephalic angle has almost disappeared. On the other hand, the lateral flap has become the most important part of the area and supplies the thumb and radial side of the hand.

Thus, as we pass downwards, area by area, the ventral attachment to the chest rapidly disappears (at fifth cervical). The dorsal attachment becomes separated from the dorsal limb and finally disappears (at seventh cervical).

The behaviour of the lateral flaps is very instructive. That of the third cervical (sterno-mastoid) lies on the ventral aspect of the shoulder joint. That of the fourth cervical has already reached the arm and lies on the ulnar aspect of the extreme upper part of the arm to the dorsal side of the lateral limb of the third cervical (sterno-mastoid). The tip of the lateral limb of the fifth cervical has shifted a little more towards the centre of the arm. That of the sixth cervical lies over the centre of the forearm; whilst the tip of the lateral flap of the seventh cervical occupies the thumb and a portion of the radial side of the back of the hand. Thus with the disappearance of the ventral limb and the increasing acuity of the cephalic angle, the tip of the lateral flap shifts gradually towards the radial aspect of the limb.

So far I have only attempted to homologise the sensory areas on the arm from the third to the seventh cervical. In order to understand the eighth cervical it will be necessary to begin from below and first consider the distribution of the fifth dorsal segment. As I showed in my first paper,[1] this area consists of a complete band round the body from back to front. But on the upper or headward side is a small flap rising towards the axilla. This represents the lateral flap.

[1] *Op. cit.*, p. 37.

Now my readers will see that this lateral flap differs from the lateral flap of the third cervical in that it lies on the headward side of the dorsal and ventral limbs of the band, whilst the lateral flap of the cervical areas was turned towards the thorax. Thus the primitive type of the thoracic areas,

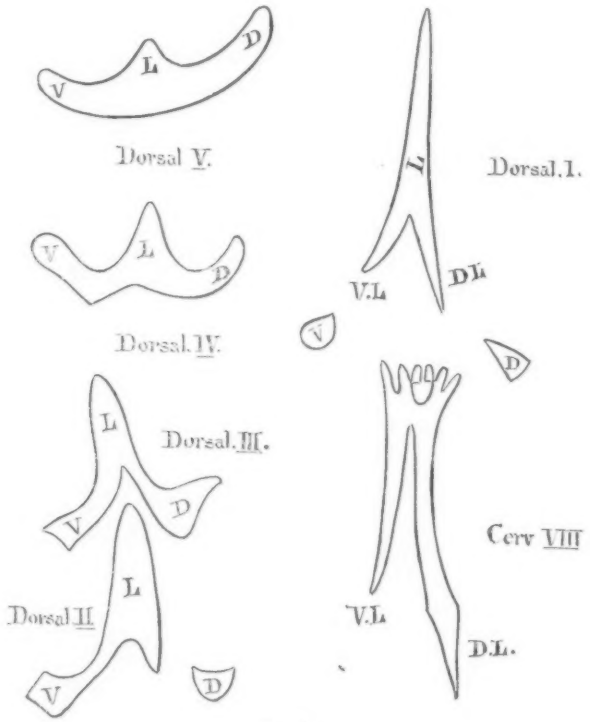


FIG. 31.

A series of diagrams to show the homologous parts of the areas from the fifth dorsal to the eighth cervical.

As before D represents the dorsal, V the ventral portion of the primitive band-like area. L represents the lateral flap. In Dorsal I. and Cerv. VIII. the angle has cleft the lateral flap, forming a ventral (V.L) and a dorsal (D.L) portion.

In each case the skin forming each area is supposed to have been stripped from the arm or hand and spread out on a flat surface. Hence that part of the hand supplied by the eighth cervical is represented like an unsewn glove. The terminal portion of the little finger thus lies in the centre without the basal phalanx which is supplied by the first dorsal area.

affected by the limb, differs from that of the cervical areas in that the lateral flap appears on the side towards the head. The position that was occupied by the cephalic angle is now occupied by the lateral flap whilst the angle is on the posterior or thoracic aspect of the band. I shall therefore speak of this angle as the thoracic angle (fig. 31).

In the fourth dorsal area the lateral flap is distinctly larger and reaches well up into the axilla, on the ventral side of the lateral flap of the fifth dorsal.

The lateral flap of the third dorsal area reaches the limb and shows a tendency to become detached from its dorsal flap whilst remaining in connection with the ventral portion of its area. Just as we saw an ever increasing acuity of the cephalic angle in the lower cervical areas, so here the thoracic angle gradually reaches a right angle.

In the second dorsal area these changes have gone still further. The lateral flap has come down the arm to the elbow, but still remains in connection with the ventral limb over the pectoralis. The dorsal limb has became completely separated as a patch over the vertebral border of the spine of the scapula.

In the first dorsal area, the lateral flap has come into the forearm, and is separated from both the ventral and dorsal portions. The remains of the thoracic angle are seen as a notch between the ventral and dorsal peaks of the lateral flap on the arm.

The eighth cervical has entirely lost its dorsal and ventral limbs, and the lateral flap is enormously elongated, and deeply cleft by the thoracic angle. It reaches the hand both back and front, and lies to the radial side of the lateral flap of the first dorsal area, both on the front and back of the forearm.

I have now traced the evolution of all the upper sensory areas from two modifications of a simple band-like type.

The areas from the third to the seventh cervical are modified by the development of a lateral flap on the thoracic side of the band, whilst the areas from the fifth dorsal to the eighth cervical arise from a type with a lateral flap on the headward side of the simple dorso-ventral band. Thus a

comparison of the eighth cervical with its neighbour the seventh cervical shows that the cleft in the former represents a thoracic (posterior) angle, whilst the cleft in the latter represents a cephalic (anterior) angle.

The sensory areas on the upper limb have therefore been developed from a primitive band-like arrangement by a process that could be represented by pushing the finger from below through a sheet of india-rubber.

As Herringham and Sherrington have both pointed out the motor distribution follows a different arrangement. For the most distal segment of the limb (hand) is supplied with motor nerves which arise from the cord lower than any others entering the arm; whilst the muscles of the shoulder are supplied by those nerves which come off from the highest level of the cord.

It is interesting to notice that, according to Sherrington,[1] the highest root area which shows traces of the coming limb is the third cervical, whilst the lowest thoracic root affected by the presence of the arm is that of the fifth thoracic. In the same way I pointed out that, of my segmental areas, the third cervical (sterno-mastoid) was the first to show a lateral flap downwards, whilst the fifth thoracic was the last to show a definite lateral flap upwards.

§ 4. *To what extent do these Areas overlap?*

I shall deal with the question of overlap as a whole in the third part of this investigation. Here I shall only touch on that part of the question which is elucidated by the distribution of the areas on the head, neck and arm.

The distance between a point on the skin over the temporal crest of the frontal bone and the middle line of the forehead, at the level of the eyebrow, varies to a comparatively small extent in adult human beings. The areas on the forehead thus form a useful criterion of the amount of the overlap. If the fronto-nasal area be tender its external

[1] *Phil. Trans.*, vol. clxxxiv., p. 750.

border reaches some three-quarters of an inch (2 cm.) from the middle line. If, on the other hand, the mid-orbital area be tender its mesial border lies about half an inch (about 1·2 cm.) from the middle line. Thus, if these two areas overlap, they do so to the extent of about a quarter of an inch (0·75 cm.). Again the posterior border of the fronto-temporal area lies about 3¼ inches (8 cm.) from the middle line, whilst the anterior or mesial border of the temporal area lies about 3 inches (7·5 cm.) from the middle of the forehead at the same level.

Now if we consider the difficulty and amount of experimental error that must attend the attempt to map out these areas clinically, a quarter of an inch (0·75 cm.) is well within the errors of observation.

Again, the posterior border of the vertical area, when well developed, extends to a point just behind a vertical line from ear to ear. The anterior border of the parietal area comes forwards just about to the same line in front.

Thus I believe that the areas of the forehead and scalp overlap to a small extent, but that the amount of overlap lies within the errors of clinical delimitation. The overlap is in no way comparable to that of the areas supplied by posterior roots. For Sherrington has shown that the areas of distribution of the posterior roots overlap to such an extent that the posterior border of A is overlapped by the anterior border of C, and B is entirely covered, in front by A, and behind by C. Thus division of one posterior root produces no anæsthesia, as was shown by Sherrington in the monkey, and by myself in man.[1] In chapter v. I shall show that the branches of the fifth nerve overlap to the same extent as the posterior roots.

The lateral areas of the cheek and jaw overlap to a slight extent, whilst the areas on the front of the neck in direct continuity with them below overlap to an extent that is clinically perfectly evident.

In the same way the third and fourth cervical do not overlap to any marked extent, whilst the areas on the arm overlap appreciably.

[1] *Op. cit.*, p. 41.

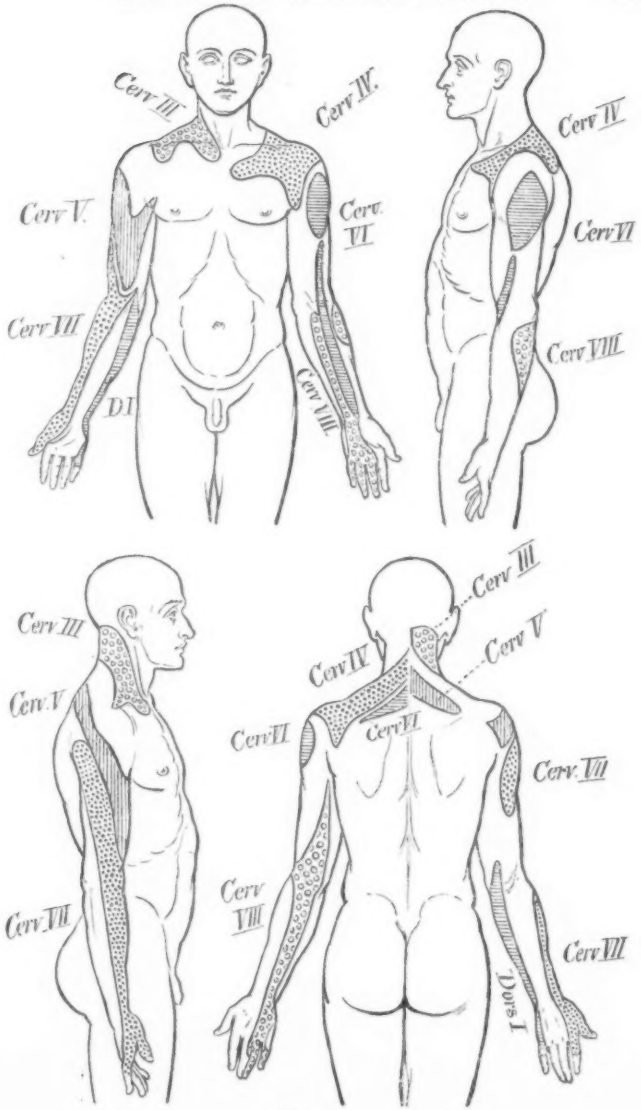


FIG. 32.

I have here attempted to show approximately the distribution of the areas from the third cervical to the first dorsal. The amount of overlap can be seen by comparing any area on the right side of the figure with that above or below it on the left side.

Thus I believe that the tender areas representing segments of the cord may overlap, but that the overlap is slight, except in those parts of the body where compression has taken place. Thus the areas on the front of the neck overlap much more than those on the side of the cheek, and the eighth cervical on the arm overlaps its neighbours above to a much greater extent than the third cervical.

For this reason the dorsal and ventral flaps of the lower cervical areas overlap to a much greater extent than the lateral flaps. Thus there is much overlapping of the crowded ventral limbs in front between the clavical and the fourth rib, and a similar overlapping of the dorsal limbs behind in the area from the fifth cervical to the second dorsal vertebral spines. These two territories might be called the "watersheds," for they form the points of separation for the streams that are flowing down the arm from above and below. This concentration explains the overlap of the dorsal and ventral limbs, so much in excess of the overlap of the lateral flap of the same area (compare the distribution of the hand from the seventh cervical, eighth cervical and first dorsal areas).

The destruction of one posterior root causes no anæsthesia, but in no case would the absence of one of these segmental areas fail to leave a gap at some point between its neighbour above and that below it in order. Thus, if even the diminished inferior laryngeal area is unaffected, a distinct gap seems to be left between the mental area which overlaps it above, and the superior laryngeal which overlaps it below.

CHAPTER II.

Pain and Tenderness produced by Lesions of Special Organs of the Head and Neck.

We have now traced the position and limits of the areas on the head and neck, which may become tender from various visceral disturbances.

In the following chapter I deal with one organ after the other in the head and neck, and discuss the locality and nature of the pain and tenderness produced by organic and functional disturbances in the activity of each organ.

§ 1. *Eye.*

Of all affections of the eye which cause pain and tenderness, some error of refraction is the commonest. A healthy young man, who has adopted some profession involving near work, begins to suffer from headache "over the eyes," or a young woman, otherwise in perfect health, finds she cannot sew without bringing on a headache. In out-patient practice the child who suffers from headache during its lessons, appears with considerable frequency in these days of Board schools.

If asked to point to the situation of the pain, these patients, as a rule, place the right hand over the forehead with the hypothenar eminence over the centre of the right eyebrow, and the second phalanges of the four fingers over the centre of the left eyebrow. Now this position of the hand has led to the common statement that the headache is "frontal." But the patient himself states that the headache is "over the eyes," and when asked to point with two hands to the position of the headache, he places the tips of the fingers over the centre of each eyebrow.

If we now pick up the skin gently between the finger and thumb the patient winces as soon as a spot is reached about three-quarters of an inch (2 cm.) from the middle line on either side. If the blunt head of a pin is used he complains that he is tender, or that he is being pricked, as soon as an area over the centre of the eyebrow is reached. By either of these methods the headache produced by hypermetropia is found to be associated with superficial tenderness over more or less of the area I have called the mid-orbital. (*Vide* p. 10, fig. 2.) As a rule in a pure case of hypermetropia the maximum only of this area is present, but occasionally, especially if the patient is seen immediately after reading or

sewing, the whole area, including the patch on the front of the hairy scalp, may be tender.[1] (Case 2.)

If due to hypermetropia the headache will be found to be worse over that eye in which the error of refraction is greatest.

This headache has certain peculiar characteristics. It comes on in the morning as soon as the eyes are opened, is then most intense and gradually wears off during the day if the patient does not engage in any near work. It is intensified or produced by reading and sewing. It disappears if the eye is put under atropine.

Sometimes, when brought face to face with a headache accompanied by mid-orbital tenderness, it is not easy to say whether it be due to an error of refraction, which is undoubtedly present, or to some other cause. In such a case before correcting a slight error of refraction it is well to make sure of the following points.

(1) The headache is definitely made worse by reading and sewing.

(2) It comes on in the morning as soon as the eyes are opened.

(3) It disappears under atropine applied for a sufficient length of time to paralyse accommodation. (Compare Case 52, p. 454.)

(4) There is absolutely no pain or tenderness elsewhere in the body, and, especially, no tenderness over those areas of the body which are definitely associated with the mid-orbital. (*Vide* pp. 452 to 457.)

If, however, pain and tenderness are present elsewhere in the body, or if the patient is anæmic, it may be quite impossible to say whether the hypermetropia present is really the cause of the headache.

It is interesting to find that whilst this headache comes on in the early morning in those who lead an ordinary life, it makes its appearance in the evening in those who work at night and sleep in the day. Thus nurses on night duty who suffer from hypermetropia develop the headache on getting

[1] Patients who come to the hospital have not, as a rule, exercised the eyes with near work on the day on which they come.

up in the afternoon; but as soon as they change on to day duty the headache shifts its time of appearance and comes on in the early morning.

Thus hypermetropia causes a well-marked headache "over the eyes," frequently accompanied by a feeling of aching "in the eyes"; and this headache is associated with superficial tenderness over more or less of the mid-orbital area.

On the other hand simple myopia, however high the error may be, causes no such headache and tenderness. The myopic sometimes complain of a "tired, aching feeling" over the forehead. This cannot be definitely localised, and is unaccompanied by superficial tenderness of the forehead. It is never present except after a long and tiring round of looking at objects at a distance (*e.g.*, picture gallery), and is always absent after a night's rest.

There is, however, one condition in which simple myopia may produce a mid-orbital headache associated with tenderness. I allude to those uncommon cases in which myopia is associated with spasm of accommodation. This headache, like that produced by hypermetropia, entirely disappears under atropine.

In progressive myopia the conditions are somewhat different. For in this disease destruction is progressing at the back of the eye. Patients suffering from this disease sometimes complain of pain "on the top of the head," and I have seen tenderness of the hairy scalp in such cases which may have been connected with the changes in the eye. Such patients far more commonly complain of a pain "at the back of the eye," especially aggravated by movement of the eye. This pain is not associated with superficial tenderness and appears in many cases to be a local, as opposed to a referred, pain.

Now, as I pointed out above, many hypermetropes complain of pain "at the back of the eye." Thus there are two separate forms of pain, both of which are described by the patient in roughly the same terms "aching at the back of the eyes." The pain associated with progressive myopia seems to be a local pain depending possibly on the condition

of the back of the eye; whilst in hypermetropia the pain is referred to the maximum spot of the mid-orbital area over the upper lid, just below the centre of the eyebrow, and is therefore described by the patient as "pain in the eye." This pain of progressive myopia is not associated with tenderness over the mid-orbital area, though possibly the vertical area may be tender, whilst with hypermetropia tenderness is frequently present.

Myopic astigmatism, when uncomplicated, does not produce referred pain or tenderness. On the other hand, hypermetropic astigmatism is an even more fruitful source of headache and tenderness over the mid-orbital region than simple hypermetropia. Thus, whereas a simple error of + 1 or + 2D. can sometimes be neglected, an astigmatic error of + 1D. will frequently produce the most definite pain and tenderness.

What is the cause of this referred headache and tenderness associated with hypermetropia? The following points seem to shew that it is due in some way to the ciliary muscle. (1) Its appearance with hypermetropia and not with myopia seems to show that it is due to that part of the eye which is strained in hypermetropia, *i.e.*, the ciliary muscle. (2) Its disappearance under atropine points to the same conclusion.

At first sight the occurrence of this headache on waking in the morning would seem to tell against this hypothesis; but I think it may be explained as follows. During sleep the mechanism of accommodation comes to rest, and any spasm of accommodation, present during the day, slacks off. But as soon as the eyes are opened the tone of the ciliary muscles increases rapidly. Now the amount of pain caused by any physiological process, such as the contraction of the ciliary muscle, depends not so much on the amount of the contraction as on the suddenness with which the contraction takes place. Thus a considerable physiological effect can be produced without pain, provided the end be attained slowly, whilst the attainment of a smaller effect may act as a more violent stimulus if the height of contraction be quickly established. When the eyes are opened

in the morning the curve of contraction rises rapidly and pain is produced. After a while adaptation takes place, and, although the same contraction may be maintained, the pain lessens. It is then revived by some additional strain, such as that involved in near work.

Anything which tends to produce a permanent abnormal tone of the ciliary muscle will produce referred pain. Thus unsuitable glasses may cause more headache and tenderness than the original error of refraction.

This view is supported by the absence of referred pain and tenderness when presbyopia is fully established. A patient may have been hypermetropic and have suffered from pain over the eyes all his life without appreciating that he had an error of refraction. When the error manifests itself with the onset of presbyopia, his vision fails for near objects, but his headache improves. Thus headache may be present at 40 but not at 50.

The same amount of effort which is painless with a strong ciliary muscle may become painful if the muscle is weakened, either directly or by a deterioration of the general health. Thus, headache may persist, and be associated with tenderness up till the time that presbyopia is fully established. Again, children will bear an error of + 3D. without pain if in good health. But many London children now come to our hospitals complaining of mid-orbital headache, associated with definite tenderness, for which no cause can be found beyond an error of + 1·5 to + 2D. Such children occasionally lose the headache and tenderness under a course of treatment directed towards the improvement of the general health. Many men living the tiring and insanitary life of a resident in a general hospital will develop a hypermetropic headache for the first time in spite of the fact that there is no obvious increase in the amount of near work.

Affections of the conjunctiva or of the outer layer of the cornea produce no referred pain. Injury to the surface epithelium of the cornea produces an intense smarting pain, which is well defined and local. It is exactly equivalent to the well-known local pain produced by injuries to the conjunctiva.

If, however, the deeper parts of the cornea be affected, as in deep and ragged ulcers of the cornea, or if the depth of the anterior chamber be increased, marked reference may take place. The patient complains of pain over the forehead, and more or less of the fronto-nasal area may be tender (fig. 1, p. 346). As a rule, however, the maximum only of this area is present, for if the affection of the cornea is sufficiently grave to produce superficial tenderness over the whole fronto-nasal area, some part of the mid-orbital area will also appear.

The figure to illustrate this point (fig. 1, p. 346) is taken from a case (No. 1) in which the so-called "serous iritis" formed the beginning of a fresh attack of interstitial keratitis. Now although pathologically, the ciliary body is probably at fault in the production of keratitis punctata, from the point of view of pain, I believe the deepening of the anterior chamber is the most important factor. For, as I have all along pointed out, alterations in pressure are the most effectual stimuli for the production of referred pain (associated with tenderness). Now, in keratitis punctata, opacities do not form in the vitreous as in, what is known as a true, cyclitis; but on the other hand the anterior chamber is deepened. In correspondence, I think, with this difference true cyclitis produces pain and tenderness in the mid-orbital and fronto-temporal regions, and probably even posteriorly to the fronto-temporal, whilst keratitis punctata produces pain and tenderness over the fronto-nasal and mid-orbital areas.

Case 28.—Charles S. (U.C.H., Mr. Tweedy), aged 13.

Four years ago his eyes became blood-shot. He gradually went blind and remained so for several months; he then improved, but the left eye has recently become worse.

Admitted November 21, 1892.

Not cachetic. Bridge of nose good. No scars about angle of mouth. Teeth not notched.

Lids and puncta normal.

Anterior and outer part of the globe of both eyes is of a purple colour. This is seen to be due to an inflammation and congestion of the deep structures in the region of the ciliary body. This inflammatory condition in the ciliary region is associated with the enlargement of some of the conjunctival vessels. The

conjunctival, as opposed to the ciliary injection, is, however, very slight. The cyclitis is exceedingly chronic in the right eye, but somewhat more acute in the left eye.

Right cornea clear, but there is a hazy white nebula almost exactly in the centre of the left pupil.

Pupils medium size—4½ to 5½ mm. in diameter; equal. Iris a fair colour. No synechiæ. Pupils react to light and accommodation well and regularly.

Vision R. eye $\frac{6}{12}$, well. Jæger 1.
L. eye $\frac{6}{60}$ (the letter is indistinct from haze), Jæger 16 (sideways).

He complained of pain over the centre of the left eyebrow and "in the left temple." This pain was associated with some superficial tenderness over the mid-orbital (maximum only) and fronto-temporal areas. This pain and tenderness was never very severe and rapidly passed off under treatment.

Thoracic and abdominal viscera healthy. Bowels open daily. No cause for pain found in any other part of the body.

Should the substance of the iris be inflamed the pain is usually said to be "on the temple" or "in the cheek." Corresponding to this pain superficial tenderness may be present over the fronto-temporal, maxillary, and temporal areas. This implication of one, or both of the two temporal areas explains, I believe, the relief caused by the application of the leech to the "temple." For the maximum of the fronto-temporal area lies just above the outer extremity of the eyebrow, that of the temporal area a little behind it; and it is close to one of these points that the leech is usually applied.

I give two cases in illustration of the tenderness produced by affections of the iris. In the first (Case 29) a foreign body was removed somewhat clumsily, and slight iritis followed in a few days. This patient suffered from pain in the left "temple" and "cheek" associated with tenderness over the fronto-temporal and maxillary areas. The second case (Case 30) was one in which iridectomy was performed for blocked pupil, and the iris somewhat extensively lacerated owing to the difficulty of the operation. In this case the patient complained of pain over the left cheek after the operation, and some tenderness was present occupying the maxillary area.

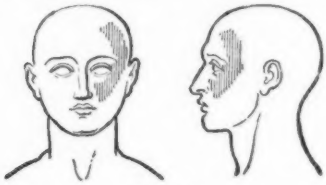


FIG. 33.

Shows the distribution of the tenderness in a case of slight iritis (Case No. 29). The areas affected are the fronto-temporal and maxillary.

Case 29.—Henry D. (Mr. Tweedy), aged 30.

November 17.—Something fell from the ceiling into his left eye whilst he was engaged on his work as a paper-hanger. He came to the casualty department and "a foreign body" was removed.

November 19.—He began to suffer from more pain.

November 21.—Ciliary injection and distinct signs of iritis. Pupil bound down. Under atropine, the pupil dilated, leaving a ring of uvea on the anterior capsule.

He complained of pain in the left "temple." Definite superficial tenderness of the fronto-temporal and maxillary areas.

The whole of the pain and tenderness had disappeared when seen a week afterwards. The left eye was deeply under atropine.

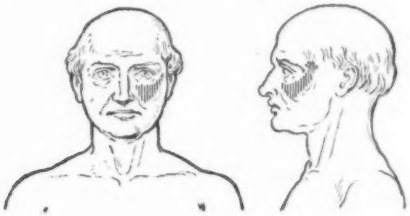


FIG. 34.

To show the superficial tenderness which followed an operation on the iris (Case No. 30). The area affected is the maxillary.

Case 30.—Thomas V. (U.C.H., Mr. Tweedy), aged 70.

About Christmas, 1891, his eyes became red and inflamed. Much headache over forehead and top of the head. In two or three weeks "inflammation" had subsided, and vision was reduced to present condition.

October, 1892, condition as follows:—

Vision, right and left, hand movement and light and darkness only; cannot count fingers.

Complete posterior synechiæ and occlusion of pupils.

Tension about normal in both eyes.

No pain; no tenderness. Pulse 80, regular; arterial wall much degenerated and very hard.

No abnormal physical signs in chest beyond those of emphysema.

Urine 1020 sp. gr., acid, no albumen or sugar.

October 6.—Iridectomy upwards in right eye.

October 20.—Good recovery and absence of pain or tenderness.

An iridectomy was performed to-day on the left eye. The iris tore and the operation was more difficult and less satisfactory than that on the right eye.

October 21.—He is complaining of a little pain and there is distinct tenderness over the maxillary area (fig. 34) to the head of a pin. This tenderness was present for nearly forty-eight hours.

November 24.—Right eye, good coloboma upwards. Total posterior synechiæ. Sphincter portion of iris at coloboma still adherent. Lens seems clear, but disc and fundus cannot be seen. Vision: sees fingers vaguely, but cannot count them.

Left eye, jagged coloboma down and in. In this eye uvea only is left opposite coloboma. Lymph in pupillary area. Vision: hand movement only.

Should the tension in the vitreous chamber rise, as in glaucoma, the chief pain shifts further back, and is mainly referred to the temple. Thus in true glaucoma the pain may lie over the fronto-temporal, temporal, and maxillary areas, but the maximum pain is referred into the temporal area. All these areas may be more or less tender. The teeth of the upper jaw ache on the side affected. If the pain and tenderness spread forwards to affect the frontal area the teeth of the upper jaw ache up to the middle line, and if the pain and tenderness spread back behind the temporal area, as it not uncommonly does in an acute attack of glaucoma, the teeth of the lower jaw may also ache. Occasionally the teeth affected are tender to percussion as though periodontitis were present. That this tenderness is reflex, and not due to any actual change in the sockets of the teeth is shown by the daily variation, during the progress of a particular case, in the position and number of the tender teeth—a variation which seems to be related to the number and position of the areas which are tender on the surface of the head.

The case I have selected to illustrate these points (Case 4) was one of acute glaucoma (fig. 4). It shows this

temporal area in a striking manner. Usually, however, the pain and tenderness in acute glaucoma are more widely spread, but I selected this case more with a view to illustrating the temporal area than of showing the commonest sensory changes in acute glaucoma. But whatever other areas may be affected this temporal area is the first to come and the last to disappear when the tension rises in the vitreous chamber.

Now vomiting is an exceedingly common occurrence in acute glaucoma, and I cannot help thinking that this proneness to nausea and vomiting is due to the primary implication of this temporal area. For, as I pointed out above (p. 13), and as I shall show later on (p. 107), this area is peculiarly associated with the act of vomiting, and its attendant nausea. Thus, I think it is probable that the early appearance of vomiting in acute glaucoma may be due to the fact that a rise of tension in the vitreous chamber of the eye causes tenderness over the temporal area—an area which is from other causes peculiarly associated in the nervous system with the act of vomiting and the feeling of nausea.

It is exceedingly difficult to determine what special areas, if any, are associated with disturbances of the retina and optic nerve. Detachment of the retina, if it occurs suddenly is sometimes associated with tenderness over the vertical area, and pain "over the top of the head" (Case 31). After excision of the eyeball, pain is, as a rule, absent, but such cases may sometimes complain of pain on the "top of the head," and occasionally superficial tenderness may be present over the vertical area of the scalp (Case 5, p. 15).

Case 31.—William H. (U.C.H., Mr. Tweedy), aged 19, butcher.

September 9.—His left eye "dazzled," "the place seemed foggy." A light shade appeared over the sight, which rapidly became darker. No history could be obtained of injury or of previous defect of vision in this eye.

September 11.—Came to Eye Department, U.C.H. Marked detachment of retina of left eye. Taken into hospital and put strictly to bed with eyes bandaged.

He complained of pain "which kept bobbing up from the eye to a place on the top of the head." He says the top of his head is sore and that the hair is tender.

Very definite superficial tenderness over what appears to be the vertical area of the scalp. The posterior border touches the vertical line from ear to ear, and the anterior border does not involve the extreme front of the hairy scalp. It is strictly limited to the left side of the head.

October 17.—Bandages removed. Condition of the left eye as follows: Pupil dilated. Small hazy patch at lower and outer periphery of lens. Fine dust-like opacities in lens and vitreous. Extensive detachment of lower part of retina. Retina stippled with proliferated pigment. It is pink over the greater part, but with a few grey bands here and there. Summit of the detachment seen with + 8D. Marked diminution of the lower quadrant of the retinal perimetric field of the left eye (upper projected field).

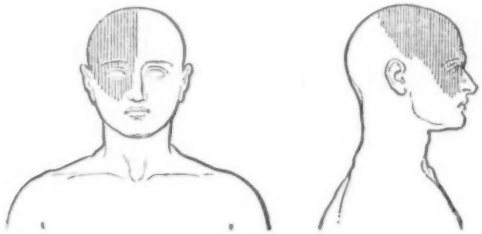


FIG. 35.

To show the extent of the skin of the scalp and face which may become tender as the direct result of lesions of the eye.

To sum up the conclusions to which we have arrived in this section.

(1) The pain associated with lesions of the conjunctiva and anterior layer of the cornea is local and not referred. The patient is guided to the position of the lesion by the situation of the pain, just as we are guided to the position of an injury to the skin by the situation of the pain it causes.

This also applies to lesions of the socket which do not involve the eyeball directly (*e.g.*, orbital growths, &c.).

(2) Lesions or disturbances in the eye from the substantia propria of the cornea back to the retina produce referred pain—that is, pain which is not felt directly at the seat of the disease—in addition, it may be, to local pain. This pain, if sufficiently acute and of some duration, is

frequently accompanied by superficial tenderness of the coverings of the head and face.

The areas that may become tender from diseases of the eye are shown in fig. 35 and extend from the fronto-nasal back to the vertical.

(3) The more anterior the lesion in the eye the more the frontal areas tend to be implicated. The further back the lesion, the more readily does the vertical area tend to make its appearance.

Deepening of the anterior chamber is associated with tenderness over the fronto-nasal area and its immediate neighbours; rise of tension in the vitreous chamber is associated primarily with the temporal area and then with those around it.

§ 2.—*Teeth.*

For the purposes of this investigation the pain and tenderness produced by disease of the teeth form a most instructive field of research. For even the most healthy suffer from time to time with toothache, and thus we are able to watch the effect produced by visceral disturbance in a person otherwise in perfect health. The second great advantage of working with the material provided by diseases of the teeth is the certainty with which we can determine the lesion that causes the mischief. The tooth is removed, split and examined, and we can note what conditions favour the production of local pain or of referred pain with its associated superficial tenderness.

Teeth stand in a curious position compared with other organs of the body, in that they lie in a cavity where the necessary conditions for the development of powers of localisation are fulfilled. It is for this reason, I believe, that a local pain will persist in the teeth later than in any other organ of the body.

The first stage of caries of a tooth consists of removal of the enamel and excavation of the underlying dentine. During this process pain may or may not be present; but provided the dentine is affected, pain can mostly be elicited by

stimulation. The most effectual stimulus in these conditions is heat and cold, for in many cases where a carious portion may be cut away without pain, a jet of hot or cold water or the blast of the chip syringe will produce a twinge of pain. Now as long as the pulp cavity is not exposed, the pain remains local. The patient will complain of an aching tooth and will point to the one affected. The pain may "dart" and "shoot," but the darting and shooting are practically confined to the aching tooth. Local stimulation produces local pain. "Neuralgia" is absent and no tenderness appears in the skin of the face.

In this stage the pain produced by the tooth is exactly analogous to that produced by injuries to the conjunctiva or outer layer of the cornea—it is purely local and points to the seat of injury.

If, however, the pulp cavity is exposed, the pain alters in character and distribution. It starts in the affected tooth and darts and shoots into the face, forehead, neck or ear. Each stab of pain lasts a few moments, only to be followed more or less rapidly by a second twinge. This is the well-known "neuralgia" caused by affections of the teeth.

On testing the face or neck during this "neuralgia" some one or more of the areas I have described will be more or less tender. On the face this tenderness is superficial, but as I pointed out above, parts of the jaw, mouth or tongue may be tender at a distance from the affected tooth, owing to their intimate connection with the distribution of these areas. Thus teeth at a distance from that affected may ache and be tender to the touch.

In testing this tenderness on the forehead or upper part of the cheek the blunt head of a pin may be used owing to the presence of a firm bony substructure. But on the lower part of the cheek or neck it is better to gently pinch the skin between the thumb and fore-finger. For in these parts the head of the pin is liable to press on tender underlying structures, and thus lead to error. (*Vide* p. 5 and 6.)

Many patients are aware of the presence of this tenderness, and will tell you that they first have the darting and shooting, and then it "seems to leave a soreness." When

the tender area is reached in testing the face it is not uncommon for the patient to say "When you touch me there, it seems to make my tooth worse." They complain more often that they are "sore, tender, bruised" when touched with the blunt head of a pin than that they are being "pricked."

This tenderness is not developed until the "neuralgia" has lasted several hours, and usually disappears within 24 hours of the removal of the tooth. Under certain circumstances the tenderness may persist and spread widely, extending even on to the arm. Such cases will be dealt with in Part iii. of this investigation when I speak of generalised tenderness or "spread."

It may happen that when the patient comes under observation the pain has ceased for many hours. In such cases tenderness will probably be absent. And yet from the account given by the patient of the nature and course of the pain it was obviously referred and not local. For the purposes of scientific investigation such cases are useless. But for diagnostic purposes, the patient's account only, may frequently be of value. For referred pain is localised by the patient in the maximum spot or spots of the tender area affected. Thus given a knowledge of the distribution of the tender areas and their maxima, it is easy to determine to what area the referred pain must have belonged, and thus indirectly to arrive at the peccant tooth. For instance, pain in the ear is associated with the hyoid area, and thus if the patient tells us that he has had earache we know that he has suffered from that referred pain which is frequently associated with tenderness over this area. Now tenderness over the hyoid area is associated, as I shall show below, with disease of the second bicuspid, and first and second molars of the lower jaw. And thus we can argue back that our patient with referred pain in the ear is suffering from disease of one of these teeth.

After caries has reached the pulp cavity many different changes can occur. The pulp and nerve become inflamed and reddened, and die rapidly and steadily. But sometimes this death takes place much more slowly. One part or the whole of the pulp in the chamber may die, and with it the

nerve in one or more roots, and yet the nerve in one root may remain alive and potent for harm for a long while. Or the inflammation and death of the pulp may go on slowly under a cap of sodden dentine. If the pulp becomes fibrous or calcareous, it no longer causes referred pain. But such cases are, in my experience, frequently deceptive; for although the nerve in one root may pull out like a cotton thread, it is not uncommon to find that another root contains a small vestige of living pulp. Irregular calcification with the formation of pulp stones frequently leaves some living pulp, and is a frequent cause of referred pain. The condition known as "polypus of the pulp" is frequently associated with a living nerve. I have an impression that where the polypoid formation is large the nerve is likely to be dead; where, on the other hand, the fungating portion is small, the nerve will probably be alive. The point of the probe will settle this at once. For should the nerve be alive the least touch with the point on the protruding granulation tissue will cause exquisite pain. These cases show beautifully marked superficial tenderness of the face.

When the pulp and nerve are dead the tooth may still be a source of pain, owing to inflammation of the periodontal membrane or abscess about the tooth. But this pain, in the vast majority of instances is local and not referred,[1] and neither follows the lines indicated in this paper, nor is accompanied by superficial tenderness. When periodontitis is present the tooth frequently seems as if it were "too long," or "longer than the teeth around." Intermittent pressure (as in chewing) on such a tooth causes pain, but steady pressure relieves the pain for a while. Sometimes pressure on a tooth in this condition is said to cause "darting" pain which travels beyond the limits of the tooth. Thus, on pressing a lower bicuspid which seemed to the patient to be longer than its neighbours, the pain was said to "run along the jaw." In the same way pressure on an upper canine produced pain darting up in the line of the socket. Neither of these cases, however, referred the pain to any maximum on the

[1] Occasionally apparent exceptions crop up. I hope to be able to deal with these shortly in a more special paper on pain due to diseases of the teeth.

face, and there was no superficial tenderness. Both teeth reacted to tapping, but not to the point of the probe, and after extraction the pulp was found to be dead and the periodontal membrane much inflamed. Possibly this darting pain may be caused by pressure transmitted from the swollen root structures to some fine nerve trunk running in their neighbourhood. For this darting differs from that of referred pain in the fact that it only occurs on direct irritation of the tooth and is not spontaneous.

Thus, in tracing dissolution of a tooth we first find local pain and tenderness produced by early caries with a healthy pulp; then referred pain accompanied by more or less superficial tenderness, with chronic inflammation and destruction of the pulp tissue; lastly, after death of the pulp, local pain and local tenderness associated with periodontitis or abscess at the root of the tooth. If this be true we are enabled to say whether pain following the filling of a tooth is due to the progress of destructive processes in the nerve of the tooth, or to periodontal irritation. For if the tooth has been carelessly stopped without sufficiently cleansing the cavity, destruction of the pulp will continue, and the pain will follow lines of reference, and superficial tenderness may be present on the face. If, on the other hand, the filling is perfect, but the periodontal membrane at fault, the pain and tenderness will be local and not referred.

I now pass on to consider the position of the pain and tenderness produced by disease of each separate tooth.

Disease of the two upper incisors causes pain, shooting up from the teeth to the forehead. This pain is associated with tenderness over the fronto-nasal area. The nose seems to swell on the side affected, and the patient complains of frontal headache or frontal neuralgia (fig. 36).

It is interesting to notice that the tenderness caused by affections of the substance of the cornea also falls over this area. Here we again meet the well-known association of the cornea with the incisors, expressed in the arrangement of the nervous system.

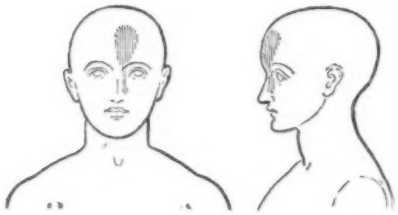


FIG. 36.

To show the area of tenderness produced by caries of the upper incisor teeth (Case No. 30). The area affected is the fronto-nasal (*cf.* fig. 1).

Case 30.— Eliza T. (National Dental Hospital), aged 34. Married.

For two years on and off the left central incisor has given trouble.

The least cold touching the tooth starts the pain. It darts up the left side of the nose to the forehead. Left side of the nose seems to swell.

When shooting pain is finished dull aching pain comes on in forehead. This is a regular dull aching headache over the front of the forehead to the left side.

Marked superficial tenderness as in fig. 36.

The left central incisor reacts to the point.

After extraction the pulp was found to be just exposed, pink, inflamed and living.

She has no pain elsewhere in body. No pain after food. No pain or tenderness of the shoulders.

Menstruation regular and painless. She is not menstruating now. Not pregnant.

The canine and first bicuspid of the upper jaw refer into the naso-labial area. Fig. 13, p. 28 shows the tenderness produced by disease of the canine of the upper jaw.

The second bicuspid in the upper jaw is somewhat anomalous. Sometimes it refers into the maxillary area, but in other cases it refers into the temporal area (fig. 37). I have never seen disease of the second bicuspid alone cause tenderness over both temporal and maxillary areas, but occasionally it distinctly affects the temporal area, and at other times equally definitely the maxillary area. Thus, this tooth seems to have an alternative nerve supply, so far as I have been able to see at present, and may cause tenderness over either the temporal or maxillary areas.

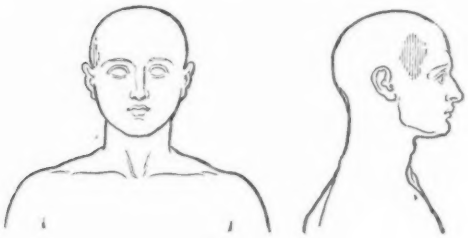


FIG. 37.

To show the area of tenderness produced by caries of the second upper bicuspid in Case No. 31. Occasionally, however, this tooth causes tenderness over the maxillary area.

Case 31.—Thomas B. (National Dental Hospital), aged 18.

He complains of pain "flying up from the tooth in the upper jaw to the right temple." He points to the second bicuspid. He says the pain seems to shoot up from the tooth deep in the jaw and then come out on to his face at the temple. He has had this pain on and off for a month. When pain is very bad he occasionally feels sick. It "turns him off his food," but he has not vomited.

Tenderness over the area in fig. 37.

No pain or tenderness elsewhere in the body. No pain at epigastrium. No cough. No wasting.

The right upper bicuspid reacts to the probe. The left lower first molar also reacts.

After extraction the pulp of the second right upper bicuspid was found to be much inflamed. Exposed, but living. No periodontitis.

Case 32.—Samuel H. (National Dental Hospital), aged 19.

June 22.—For some time he has been suffering from neuralgia over both cheeks, and much pain in the upper jaw on both sides. He went to a dentist who attempted to remove a tooth on the right side, and another tooth on the left side of the upper jaw. Since then the "neuralgia" has been much more troublesome.

Beautifully marked superficial tenderness over the maxillary area on both cheeks.

In the position of the second bicuspid on both the right and left side of the upper jaw is a stump which is exquisitely tender to the point of the probe. On the right side of the upper jaw a second stump also reacts, probably that of the first molar.

On June 22 the stump of the second bicuspid on the left side of the upper jaw was removed with some difficulty. It appeared

to have been fractured. The pulp was living, reddened, and swollen, with a distinct tendency to the formation of a polyp of the pulp.

June 24.—The neuralgia has entirely disappeared from the left side of the face, but is as bad as ever on the right side.

No tenderness of left cheek, but definite superficial tenderness of right cheek, over the maxillary area as before.

The stump of the right upper second bicuspid reacts to the point as before. A similar stump belonging to the first molar also reacts to the point.

Both these stumps were removed. Both teeth have been fractured, and the pulp is reddened living and exposed. No periodontitis.

June 26.—All "neuralgia" and tenderness of the face has disappeared.

Disease of the first upper molar usually causes pain and tenderness over the maxillary area on the cheek (fig. 8).

Case 33.—Annie W. (National Dental Hospital), aged 18.

She complains of pain in the first molar on the left side of the upper jaw.

She has also had pains "in the face" off and on for a month. It has been continuous for the last five days. When asked to indicate the position of this pain in the face she places the fingers over a spot on her cheek in a vertical line dropped through the centre of the pupil a little above the horizontal level of the upper part of the ala of the nose.

Definite superficial tenderness over the maxillary area on the left cheek.

Very healthy-looking girl. No pain elsewhere in the body or head.

The first upper molar on the left side reacts to the point of the probe. No other teeth react.

After extraction both external and internal roots contained a reddened living nerve.

The second molar of the upper jaw causes tenderness over the mandibular area of the cheek. The pain is said to be just in front of the ear, slightly above the articulation of the jaw (Case 9, fig. 9).

The upper wisdom tooth (third molar) causes pain and tenderness as a rule in the mandibular area. Thus this area is shared by the two last molars of the upper jaw. Occasionally, however, the upper wisdom tooth seems to cause tenderness not only over the mandibular but also over the hyoid area.

The lower incisors are difficult teeth to investigate owing to the comparative rarity with which they are affected. Moreover, they are so rarely implicated alone that an additional element of doubt enters into the determination of their area of reference. I have, however, in the course of the last year, collected several pure cases, and believe they refer into the mental area of the lower jaw. This area is also shared by the canine (fig. 14, p. 367) and the first bicuspid of the lower jaw (case 14, p. 367).

I am still uncertain with regard to the area of the second lower bicuspid. It sometimes seems to refer into the hyoid area and sometimes into the mental area.

The first and second molars of the lower jaw cause pain in the ear and just behind the angle of the jaw, associated with tenderness over the hyoid area. (fig. 10). When this area is affected the edge of the tongue is tender to the touch on the same side as the diseased tooth (case 10, p. 361).

The lower wisdom tooth is exceedingly interesting, in that it refers over the superior laryngeal area of the neck (fig. 11). The patient complains of pain "in the throat" or neck, and not uncommonly complains that the collar rubs against a sore place in the neck (case 11, p. 363).

During eruption of the lower wisdom tooth the pain and tenderness may lie in the hyoid and not in the superior laryngeal area. This I believe to be due to the irritation of the root of the second molar by the pressure of the erupting wisdom tooth.

The widespread pain and tenderness extending down the arm to the thumb, which occasionally appears during irritation of the lower wisdom teeth, will be dealt with in Part iii., when I speak of the laws which govern the "spread" of referred pain and tenderness.

Thus to sum up the results to which we have arrived in this section :—

(1) The incisors of the upper jaw refer on to the fronto-nasal area of the forehead (fig. 36, p. 411).

(2) The canine and first bicuspid of the upper jaw refer on to the naso-labial area (fig. 13, p. 366).

(3) The second upper bicuspid refers on to the temporal or on to the maxillary area (fig. 37, p. 412).

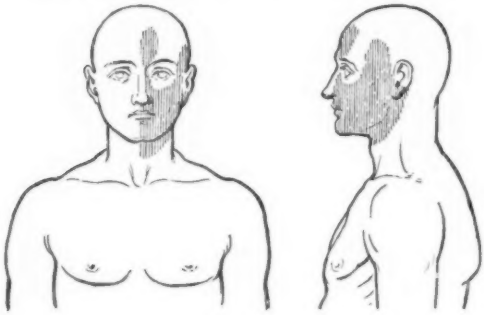


FIG. 38.

To show the extent of skin on the head and neck that may become tender from disease of the teeth.

(4) The first upper molar refers on to the maxillary area (fig. 8, p. 358).

(5) The second molar and wisdom tooth of the upper jaw refer on to the mandibular area (fig. 9, p. 359).

(6) The incisors, the canine, and the first bicuspid of the lower jaw refer on to the mental area (fig. 14, p. 367).

(7) The second lower bicuspid is doubtful, referring apparently on to the mental or hyoid area.

(8) The first and second lower molars refer on to the hyoid area and cause pain in the ear (fig. 10, p. 361).

(9) The lower wisdom teeth refer on to the superior laryngeal area of the neck (fig. 11, p. 363).

§ 3. *Ear.*

The pain produced by lesions of the auditory meatus, from its opening to the membrana tympani, is local, although frequently severe.

If, however, the membrana tympani or middle ear be affected the pain will be referred to some point at a distance from the source of irritation and may be accompanied by superficial tenderness.

When the membrana tympani is affected the middle ear is generally diseased. But in some cases where an accumula-

tion of cerumen in the meatus is decomposing, the membrane is found to be reddened and inflamed. In many cases the redness will subside after removal of the plug, and there is no reason to suppose that the middle ear is affected. Some cases of this kind suffer from pain "in the ear and under the jaw," and occasionally superficial tenderness is present over the hyoid area.

During suppuration in the middle ear before perforation of the membrana tympani occurs, the pain is intense. In hospital practice patients mostly wait until the membrana tympani is perforated, and the pain has somewhat abated, before finding their way to the ear department. Thus it is extremely rare to see an adult in this condition. The history given by such patients points to the presence of pain "at the top of the head" and "in and behind the ear." The pain on the top of the head abates when the discharge appears, but the pain "behind the ear" remains. Occasionally, however, the orifice, once established, becomes blocked. If this should occur the patient begins to suffer from pain on the top of the head, and in such cases I have seen superficial tenderness over the vertical and parietal areas of the scalp.

Case 34.—Emma R. (U.C.H., Mr. Pollard).

She has been slightly deaf on and off for the last five to six years, ever since typhoid fever. She has had a slight discharge from the left ear which ceased about June 2.

June 4 and 5 the left ear was very painful and discharged a little.

June 8.—Pain behind the jaw, in the ear and over the top of the head. Somewhat wide-spread and not very acute tenderness over the vertical, parietal and hyoid areas. The lobule of the ear is tender and the meatus is intensely tender.

Left ear: Small perforation through which no discharge is coming. Meatus not excoriated.

Right ear: Membrana tympani destroyed. Granulating spot on posterior part of inner wall of tympanum.

She improved but relapsed again, and on June 29 there was an enlarged gland behind the ramus of the lower jaw on the left side.

When a free opening is established inflammation of the membrana tympani may persist, and this I think accounts for the frequent persistence of referred pain and tenderness over the hyoid area after an acute attack of otitis media.

Thus for practical purposes the hyoid area is the most important area in ear disease. One maximum lies in the meatus and the second just behind the angle of the jaw, and the patient complains of pain at these two spots. Now, as the pain is situated in the meatus, the referred pain and tenderness are not likely to lead the ear surgeon astray when he is dealing with a case of ear disease.

But this area is shared by the posterior teeth of the lower jaw, by the tonsils, the lateral aspects of the tongue; and disease of any of these structures may cause pain in the ear. Two cases have come under my notice in which pain in the ear, accompanied by tenderness over the hyoid area, which were not due to ear disease, led the patient to consult an aural surgeon. The first of these cases came to the ear department at University College Hospital (Case 35). Mr. Pollard pronounced the ear to be healthy and all pain and tenderness disappeared when the nerve of the carious second molar on the same side of the lower jaw was destroyed with an arsenical dressing. The second case fell into the hands of an ear specialist, who perforated the membrana tympani without letting out pus or relieving the patient. Complete relief was obtained after removal of a carious lower molar with a living inflamed pulp.

Case 35.—Joseph William C. (U.C.H., Ear Department, Mr. Pollard), aged 17.

May 25.—He complained of pain in the right ear and pain behind the angle of the lower jaw on the right side. There was "tenderness over the mastoid." Mr. Pollard could find no disease of the right ear. He was treated with fomentations over the ear and jaw for four days.

May 29.—He says the pain is as bad as ever. Mr. Pollard could find no signs of disease in the ear and kindly allowed me to see the case.

There was well marked superficial tenderness over the hyoid area (closely resembling fig. 10).

He was taken to the National Dental Hospital, where the first right lower molar was found to be in the following condition:—The pulp cavity was empty, and there was secondary dentine in the posterior canal. The upper part of the nerve in this root was mummified, but lower down the nerve was living, inflamed, and exquisitely tender. An arsenical dressing was applied.

June 1.—All pain and tenderness gone. The tooth was filled.

June 2.—Absolutely no pain or tenderness. All the so-called "mastoid tenderness" has disappeared.

To sum up the results to which we have arrived in this section—

(1) The meatus auditorius does not cause referred pain and tenderness, but the pain produced by lesions of this part of the ear is local and points directly to the seat of the disease.

(2) Lesions of the membrana tympani and middle ear cause referred pain, accompanied by tenderness over the hyoid area.

(3) Elevation of tension in the middle ear, such as must occur in the first stage of otitis media before the membrane is perforated, cause pain and superficial tenderness over the vertical and occasionally over the parietal area of the scalp, in addition to that over the hyoid area.

§ 4. *Tongue.*

It is a well-known fact in surgery that malignant disease of the tongue may cause pain in the ear or over the back of the head, in addition to the local pain in the tongue itself.

Now, as I pointed out in chap. i. (pp. 360, 362, 367) each half of the tongue can be divided, with regard to its nervous connections, into an anterior, a lateral, and a posterior portion. Each of these portions stands in connection with a different area of tenderness. Thus, the anterior portion of the tongue belongs to the mental area, the lateral part to the hyoid area. The posterior part of the tongue is too far back to test satisfactorily, but we shall see in this section that it is probably related to the superior laryngeal area.

Now, it is exceedingly difficult to obtain pathological lesions which involve one only of these areas on the tongue. For tubercular ulceration is rarely of sufficient depth to cause referred pain; malignant disease is rarely confined to one part only, and is far commoner on the edges than on the dorsum; and gummata, which tend to affect the dorsum,

are decidedly rare. Thus, we are practically reduced to the pain produced by malignant disease of the tongue.

If the disease involves the anterior part of the tongue pain is complained of over a spot close to the point where the mental nerve rises through the deeper structures of the jaw to supply the skin. This, as we saw (p. 367), is the maximum spot of the mental area. This pain in the front of the lower jaw is sometimes associated with superficial tenderness over the mental area (fig. 14).

Case 36.—Frances F. (U.C.H., Mr. Heath), aged 63.

For several months she has had pain in the right side of the front of the tongue and in the front of the lower jaw. For the last six weeks this pain has been very troublesome.

February 3, 1892. Beneath the right edge of the front of the tongue, just above the ridge formed by the sublingual gland, about half-an-inch behind the orifice of Wharton's duct, is a small ulcer, surrounded by a rim of indurated tissue. The centre of the ulcer forms a deep pit, with everted edges. On the right border of the tongue above this spot some ulceration and patches of leukoplakia are seen. No enlargement of lymphatic glands.

She complains of pain over the right side of the anterior part of the lower jaw, a little behind a line drawn vertically downwards from the angle of the mouth. She also has pain in the tongue itself. Around the area of pain in the jaw there is distinct tenderness of the superficial structures both to the head of a pin, and when the skin is picked up between the fingers. This represents the mental area partially developed.

The anterior part of the right side of the tongue was removed by Mr. Heath with Paquelin's cautery.

Microscopical examination showed the growth to be a squamous epithelioma.

If the lateral part of the tongue only is implicated the patient complains of pain "in the ear," and behind the ramus of the lower jaw on the side affected. In such cases the hyoid area is not uncommonly found to be tender (fig. 39). I have no case in my collection showing complete tenderness over this area alone, and I have selected one in which the main tenderness lay over the hyoid area, but with implication of the superior laryngeal area in addition.

Case 37.—Thomas C. (U.C.H., Mr. Heath), aged 68.

About March, 1891, he became "hoarse"; then gradually a small lump appeared on the tongue like a pea.

On admission, November 7, 1891. He is thin, but not

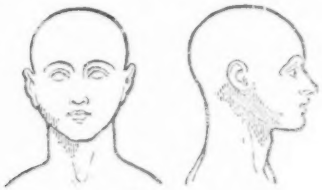


FIG. 39.

To show the area of tenderness due to malignant disease of the tongue in Case No. 37.

markedly wasted. Cannot protrude tongue to full extent. On right side of tongue about middle of its length is an ulcer which can just be filled by the tip of the finger. Exceedingly painful. Beneath the base of the jaw just opposite the situation of the ulcer, inside, is a hard secondary gland.

He complains of pain in the right ear and behind the angle of the right half of the jaw.

There is a marked superficial tenderness over the hyoid and superior laryngeal areas on the right side (fig. 39).

Mr. Heath removed about two-thirds of the right half of the tongue.

About the middle of the tongue is a shallow ulcer with raised edges. Section across the centre of this ulcer shows a yellowish white malignant mass which has invaded the tongue to the depth of at least half-an-inch (1·25 cm.). The sublingual gland is implicated by direct extension.[1]

November 27. External wound entirely healed. All pain and tenderness gone.

If the lesion is situated on the dorsum of the tongue behind a line about 3 to 4 cm. from the tip, the pain is "in the throat" close to the cornu of the hyoid bone. It may also be felt in the back of the head in addition. Occasionally tenderness is present, more commonly in the territory of the superior laryngeal, more rarely in that of the occipital area.

To illustrate the whole area that may be tender in disease of the tongue I give fig. 40. This figure shows the areas of tenderness which were present in the same case of malignant disease of the tongue on two separate occasions.

Case 38.—Richard R. (U.C.H., Mr. Barker), aged 64.

About four months before admission he began to have a little pain in the tongue. Soon afterwards he noticed a small lump, the size of a pea, on the centre of the dorsum of the tongue. This lump gradually increased in size and about a month before admission, formed a sore.

[1] This is a source of fallacy that I fully recognise in these cases.

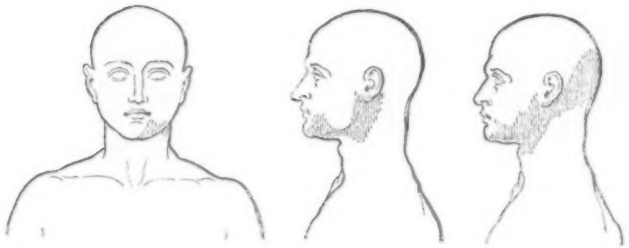


FIG. 40.

To show the areas of superficial tenderness which were present in a case of malignant disease of the left side of the tongue on two separate occasions (Case No. 38).

Three or four weeks ago he began to suffer from earache and from pain in the front of the lower jaw, just below the angle of the mouth. Sometimes the pain became very acute and is like a stab from a knife in the ear. He occasionally suffers from pain over the occipital region on the left side of the head. This he describes as a "gnawing, rheumatic pain."

All the teeth from the central incisor back to the third molar in the left half of the lower jaw ache. The second bicuspid aches most of all these teeth.

On admission (*June* 13).

Fairly nourished. No marked wasting.

On the left half of the dorsum of the tongue is a large ulcer with irregular, raised edges. The floor of the ulcer is deeply depressed and covered with a thin slough. The ulcer extends backwards from the tip of the tongue for at least 3·5 cm. The median border extends close up to the middle line of the tongue over the anterior part of the dorsum, but does not cross the middle line.

There is definite superficial tenderness over the areas shown on the two left hand drawings of fig. 40.

No teeth react to the point of a probe.

June 18.—He is still complaining of pain in the left ear, and front of jaw on left side. But he now has pain over the left occipital region, and in the region of the cornu of the hyoid bone on the left side. Swallowing causes some discomfort on the left side of the neck.

Tenderness is present to-day over the areas shown in the right hand drawing of fig. 40.

Thus at one time or another the mental, hyoid, superior laryngeal and occipital areas were tender; corresponding, I believe, to the implication of the anterior, lateral and posterior portions of the tongue.

§ 5 *Tonsil.*

When the tonsils are affected pain appears in the ear, and behind the angle of the jaw. If the disease is acute and associated with a rise of temperature, wide-spread pain and tenderness may result. This phenomena has been touched on in my previous paper (page 109), and will be treated in full when I discuss the causes of "generalisation" in Part iii.

But if there is no rise of temperature the pain produced by disease of the tonsil behaves like the referred pain from any other organ of the head. It is situated in the ear and behind the angle of the jaw on the side affected, and is often accompanied by superficial tenderness over the hyoid area. In order to avoid the complications produced by the presence of fever, I have chosen as my instance a case in which the left tonsil was in process of destruction from malignant disease (fig. 41).

FIG. 41.

To show the area of tenderness produced by malignant disease of the left tonsil (Case No. 39).

Case 39.—Arthur G., aged 50. Married.

For some time he has had a "sore throat." The pain in the throat has gradually increased and during the last three weeks he has noticed that his beard has been sore on the left side.

Probably primary syphilis in 1875. No secondary symptoms.

He has been getting thinner for a month.

June 8, 1893. He complains of pain in the left ear and behind the left angle of the jaw.

Definite superficial tenderness over the hyoid area. The meatus auditorius is extremely tender (fig. 41).

The left tonsil is infiltrated with growth, apparently malignant, producing an ulcerated surface. No secondary glands.

§ 6. *Nose.*

But few nasal affections are painful; and even in those that cause pain, the pain is but rarely acute.

In inflammatory conditions of the olfactory portion of the nose above the middle turbinate bones, pain associated with slight superficial tenderness appears over the fronto-nasal or mid-orbital areas of the forehead. Inflammation of that part of the nose associated with the lachrymal duct, so common in eye practice, occasionally lead to mid-orbital headache and tenderness (fig. 42, case 40).

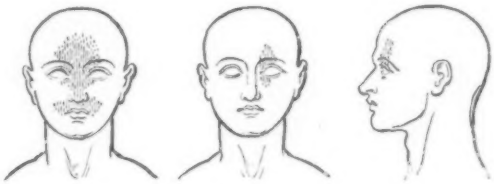


FIG. 42.

To show the tenderness which may be produced by lesions in the nose. The figure on the left hand represents the tenderness which followed an operation on the inferior turbinate bones (Case No. 41). The two figures on the right hand represent the tenderness in a case of rhinitis (Case No. 40).

Case 40.—Robert L. (U.C.H., Mr. Pollard), aged 26. Shop assistant.

August, 1891. He has been suffering from pain in the left nostril and pain over the left eye.

He cannot breathe properly through that nostril, and a whitish discharge sometimes comes from it.

Left nostril: Mucous membrane swollen and covered with glairy mucus. Septum deflected a little to the left, so that it comes in contact with the inferior turbinate. Fauces congested, pharyngeal mucous membrane swollen; one or two patches of mucus.

Ears inflated; hearing good.

August 20. Galvano-cautery to left nostril.

December 31. He still complains of pain over the left eye and there is superficial tenderness as in fig. 42.

Left nostril: Mucous membrane swollen. Excessive mucous discharge. Congestion of upper part of left nasal cavity. Turbinate bones come in contact with the septum. Plenty of room in the respiratory portion. The inferior turbinate no longer touches the septum owing to the cauterisation.

No hypermetropia.

No pain or tenderness elsewhere in the body or head.

Inflammatory conditions of the respiratory portion of the nose and of the posterior nares, occasionally, though rarely, cause pain and tenderness over the naso-labial area. If this area is tender, the patient has a feeling as if his nose and upper lip were swollen (case 41).

The connection of inflammatory conditions of the pharynx and posterior nares, with herpetic eruptions over the naso-labial area is worth notice (*vide* p. 384).

Case 41.—Alice H. (Victoria Park Chest Hospital, Dr. Thorowgood), aged 23. Single.

February, 1890.—Had "influenza" followed by "bronchitis." This lasted on and off for three months. At the end of this time she began to have attacks of true spasmodic asthma.[1]

In the course of the examination which was made after her admission to the hospital, it was found that she was unable to breathe through the right nostril, and that she breathed with great difficulty through the left nostril. The mucous membrane over the inferior turbinates was swollen.

Mr. Hovell kindly saw her at the London Hospital and found she had hypertrophic rhinitis and enlargement of the posterior extremity of each inferior turbinate bone sufficiently great to interfere with respiration.

December 2, 1893. Mr. Hovell operated after spraying the nostril with 2 per cent. cocaine. He passed his left fore-finger into the naso-pharynx and introduced a snare into the right nostril. The enlarged extremity of the turbinate body was fixed into the wire and the snare tightened. He thus removed the hypertrophied mass from the right nostril. The mass was removed from the left nostril by a similar procedure.

At two p.m. the same day she complained of a feeling as if her nose and upper lip were swollen and she had some pain over the forehead. Marked superficial tenderness was present over the areas, in fig. 42. This had entirely disappeared by the afternoon of the next day.

Thus in conclusion :—

(1) Affections of the olfactory portion of the nose may cause referred pain and superficial tenderness over the fronto-nasal and mid-orbital areas.

(2) Affections of the respiratory portion of the nose and posterior nares may occasionally cause referred pain and tenderness over the naso-labial area;

(3) But the majority of nasal affections do not cause referred pain and superficial tenderness.

[1] This case will be published in full in my paper on "Mental States in Visceral Disease."

§ 7. *Larynx.*

Affections of the larynx, though producing much discomfort and local pain, do not in the majority of cases produce referred pain and tenderness. The inflammatory conditions, apart from syphilis and tubercle, cause great local soreness, but as a rule the soreness is definitely in the larynx.

But where the larynx is in process of destruction by tubercle, the pain is not only local, but referred, and superficial tenderness may be present over one or both of the areas I have called the superior and inferior laryngeal. When the upper of these areas is tender, the pain is situated a little anteriorly to the cornu of the hyoid bone; when the lower area is affected the pain lies just in front of the anterior border of the sterno-mastoid muscle at about the horizontal level of the cricoid cartilage.

Thus, if we had to depend on pain only, it would be quite impossible to say whether it were local, or referred. That it is not truly local is shown by the presence of tenderness when the superficial structures of the neck are picked up between the finger and thumb. To demonstrate these areas in the neighbourhood of the larynx, the blunt head of a pin must not be used, for the pressure thus exerted will bring out deep tenderness in the structures of the larynx in addition to any superficial tenderness that may be present.

Syphilis and malignant disease are a less fruitful source of referred pain and superficial tenderness than tubercular disease. In many cases, however, that are otherwise painless, pain and superficial tenderness are produced by the manipulations necessary for treatment. Thus, in the earlier stages of tubercular infiltration when the mucous membrane is swollen, no referred pain is present. But treatment of the larynx with lactic acid will not uncommonly produce some referred pain and superficial tenderness of the skin of the neck.

If either the upper or the lower laryngeal area be tender, especially if the tenderness be acute, stimulation over the neck within the tender zone produces a feeling of tickling in

the throat, and each such stimulation is frequently followed by a cough. It is to these cases that applications to the neck do so much to soothe pain and irritation produced by laryngeal disease.

The laryngeal disease which causes these areas of tenderness is usually so wide-spread that it is difficult to say whether one area belongs to one part of the larynx and the other area to another. However, I cannot help thinking that where the disease lies mainly in the region of the epiglottis and aryteno-epiglottidean folds, the upper area tends to be mainly affected (Case 42). In those cases where the cords themselves are mainly affected I think the inferior laryngeal area is more likely to be tender (Case 12).

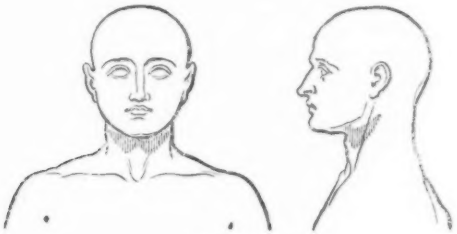


FIG. 43.

To show the areas of tenderness which were present in consequence of tubercular disease of the upper part of the larynx (Case No. 42).

Case 12, p. 364, illustrates the presence of the inferior laryngeal areas of tenderness as a result of tubercular disease of the larynx.

Case 42.—Henry H. (Victoria Park Chest Hospital, Dr. Heron), aged 26, clerk.

Quite well till the winter of 1890; then had what he calls "influenza"; pains all over, especially in the back; three weeks in bed, said to have bronchitis, never lost cough since. The next winter an exactly similar attack; sputum blood-stained. Each subsequent winter had a similar attack which lasted longer and was more severe than that before it.

Winter, 1893-94, lost his voice for the first time.

When admitted in February, 1894, there were signs of cavitation at the upper part of the right lung, with weak breath sounds, increased vocal resonance and numerous râles at right base, signs of consolidation at the left apex.

Condition of the Larynx.—Voice now fair, but he has on several occasions lost his voice. The epiglottis is greatly swollen and œdematous. The mucous membrane over the arytenoids is much swollen and pale. The cords cannot be fully seen owing to the amount of swelling. Those portions which can be seen are not ulcerated or swollen.

He has a good deal of pain in the throat, especially on swallowing. No superficial tenderness.

He gradually developed definite superficial tenderness mainly over the superior laryngeal area, and on March 20 it was solely over this area, as shown in fig. 43. By this time marked ulceration of the epiglottis had begun, and by April 5 the right side of the epiglottis had been eaten away, and there was a ragged ulcer on both arytenoids in the region where they touch one another.

Signs in the lungs advanced down the left side. He rapidly lost weight, and could only be fed under the cocaine spray.

To sum up the conclusions to which we have arrived in this section :—

(1) The majority of affections of the larynx do not cause referred pain or superficial tenderness.

(2) Certain destructive lesions, notably tubercular disease, are associated with referred pain, and this referred pain is accompanied by superficial tenderness over one or both of the areas I have called the superior and inferior laryngeal.

§ 8. *Brain.*

The headache in cases of cerebral disease varies enormously. It is mostly wide-spread over the forehead, temples and back of the head. It may affect the cheeks, neck and shoulders. It is frequently bilateral, and thus apparently loses all localising value, not even helping us to diagnose the side of the lesion.

Ferrier first pointed out that pressure on the skull frequently caused pain in cases of cerebral tumour. Since he described this tenderness on pressure, physicians have obtained such variable and discordant results that much less importance has been attached to this observation than it deserves. This is, I believe, due to a want of discrimination between deep and superficial tenderness. Ferrier described deep tenderness, which when present is an admirable localising sign.

In a typical case of brain tumour the patient is liable to attacks of headache associated with vomiting, and to a variable amount of persistent pain between these attacks. If the skin of the head is tested either during, or directly after, such a paroxysm of pain, more or less intense superficial tenderness may be present, exactly analogous to that which I have described in diseases of other organs of the head. It is generally wide-spread and not localised to small patches. If the patient suffers from pain in the inter-paroxysmal periods, this pain is also frequently associated with superficial tenderness. Obviously, then, such pain must be referred and not local.

FIG. 41.

To show the superficial tenderness which accompanied the headache due to a tumour of the choroid plexus of the brain (Case No. 43).

Case 43.—Alfred C. (Queen Square, Dr. Buzzard), aged 39. Butler.

Admitted February 22. Died June 2, 1893.

About a year ago he was first noticed to be ill. He was always sleepy and tired, and suffered from bad headaches.

Summer, 1892, he began to lose his memory and wandered about as if he did not know where he wanted to go to; got into wrong trains, &c.

The attacks of headache have occurred almost daily for the last few weeks, and are frequently accompanied by vomiting.

He has never had a fit at any time.

No history of alcohol (Butler) or syphilis. Children healthy.

On admission—Stout, thickly-built man of 5ft. 6in.

Face pale, complexion muddy. No œdema, anæmia or signs of general disease.

Mental condition varies considerably from day to day. His memory was never good, but is worse on some days than on others. He is despondent; bad-tempered; difficult to manage. Quickly loses his temper and fights with the other patients. No delusions or hallucinations. No grandiose ideas.

He suffers from periodic headaches. They occur at irregular

intervals and come on at all times of the day. No warning. The pain is mostly over the right side of the forehead and front of the scalp. When the headache is present, combing or brushing the hair on the right side of the front of the scalp gives him pain. He generally sits up and holds his head, pressing it or putting cold water bandages upon it. Going up and downstairs increases the headache slightly, but he can continue to carry trays up and downstairs, even when the headache is bad.

Sometimes he vomits immediately, sometimes not for three to four hours. In fact, he is sometimes obliged to make himself vomit to ease the pain. The headache leaves him as soon as he vomits. He loses all appetite during the headache, but feels very hungry when the attack is over. They nearly always come on after a few days' constipation. During the attack he is giddy and sees "tiny stars." No hemiopia or other visual phenomena, such as appear in megrim.

Speech unaltered.

Writing shaky and not so good as it used to be.

He can walk and stand. Does not stagger with his eyes closed. Can toe and heel a line on the floor. Grasp right 50, left 60. All movements of legs and arms well performed. No paralysis or weakness of any group of muscles. No wasting. No tremor.

No pain or tenderness anywhere except in the head.

Sensation to touch and pain good. No alteration in sense of position.

Knee-jerk equal, not exaggerated or diminished. No ankle clonus. Wrist-tap and elbow-jerk normal and equal.

Plantar and abdominal reflexes normal.

No ptosis. No ocular paralysis. No nystagmus. Pupils about 5 mm. in diameter; react to light and accommodation. Convergence good.

Sensation and motion in the face good.

Tongue comes out straight. Not wasted. No fibrillary twitching.

Palate moves well. Voice good.

Vision right and left $\frac{6}{12}$. Jæger 1 badly.

The disc and fundus oculi are normal. No neuritis. No hæmorrhages.

Smell good on both sides. Taste bad on the protruded tongue (not pathological), but present on the palate.

Hearing very good. Watch heard at a distance of one meter, right and left.

Spine and sphincters normal.

No abnormal physical signs in the thorax or abdomen.

Urine, sp. gr. 1030, acid. No albumen.

March 22. He has had several attacks of headache since admission, in which superficial tenderness was present.

He had an attack this morning associated with the tenderness shown in fig. 44. He vomited. Bowels constipated. Tongue moist but furred.

There is no pain or tenderness elsewhere in the body or neck.

He seemed to improve and left the hospital, but died April 2, 1893.

Post-mortem.—The ventricles were much dilated. To the right choroid plexus was attached a body the size of the tip of the little finger. It contained thick, curdy material. This cyst lay close to the foramen of Monro. The rest of the brain was healthy except for the dilatation of both lateral ventricles.

But a second class of case exists in which no such superficial tenderness accompanies the headache. The pain is localised within a fairly small area, and over this area pain is produced when deep pressure is made upon the head. This pain and tenderness is definitely local and corresponds to the local pain produced by pressure on a tooth affected with periodontitis.

Case 44.—Abraham W. (Queen Square, Dr. Hughlings Jackson), aged 35. Sweep.

At the age of 15 he had a fit as he was rolling down a bank. Began in left leg; then his head felt as if it were going round, and he lost his senses.

At the age of about 21 he had a second fit. It began in the left leg, and affected the left arm.

A year afterwards had a third fit, with loss of consciousness; eight to nine months after, a fourth fit, with less profound loss of consciousness.

In the last four years he has had several attacks daily, beginning in the left leg, but without loss of consciousness.

There is no history of injury or syphilis.

No family history of fits.

On admission, June 30, 1893. Strong, healthy-looking, muscular man. Very intelligent. No mental symptoms. Speech normal; weakness of left arm and left leg, compared with the right side. Fine movements of the left hand defective and slow. Cannot unbutton his shirt easily with the left hand. The movements of the left shoulder are a little weaker than those of the right. He has slight power of movement only in the toes of the left foot. Flexion of left ankle poor; extension somewhat better, but not good. Movement of left knee powerful, but not so strong as right. At hip, and on left side of trunk, movement seems good. There is distinct loss of sense of position and some diminution to touch over the left leg. Sensation of pain, heat and cold unaffected. Optic discs normal. No paralysis of any cranial nerve. Left knee-jerk exaggerated. Right knee-jerk normal. Ankle clonus obtained on left side only. Right plantar reflex present; left plantar brisk.

From July to September he had a large number of fits, in

which he did not lose consciousness. They affected the left leg and left arm, and the leg was distinctly paralysed after a fit.

September 19. Mr. Gunn thought that optic neuritis had appeared, and Mr. Horsley determined to operate.

He has complained all along that there is a sort of darting pain in the right parietal region just before the fits. For the last few days, however, he has complained of a dull, aching pain principally over the parietal eminence. This pain remains a dull ache unless he has a fit; with each fit there is a stab of pain at this point.

There is no superficial tenderness of the scalp now or at any other time. There is, however, to-day distinct tenderness on deep pressure at a point in the parietal region 1½ inch (3·75 cm.) behind a vertical line from ear to ear, and 1 inch (2·5 cm.) from the middle line of the scalp. The spot is very localised, and is not bigger than the top of the thumb. Pain can be produced either by deep pressure or by tapping (percussion).

September 27. Mr. Horsley operated and removed a considerable portion of the bone over the parietal and vertical regions. At what appeared to correspond to the ascending parietal gyrus there was a dark purple patch of injected dura about 1 cm. in diameter, corresponding to the position of tender spot on the scalp. The dura was not opened.

October 3. At the second stage of the operation by Mr. Horsley, a deep red growth was seen in the sulcus, supposed to be the fissure of Rolando, midway between the site of the genu and the margin of the hemisphere. The growth was found to penetrate for a depth of 1½ inch (3 cm.). It was soft and friable on the surface, but very hard in the corona radiata.

Now, as far as my experience goes at present, these two forms of tenderness in brain disease are fundamentally different in origin. The deep tenderness and the definitely local pain are of meningeal origin, and point either to a primary or secondary affection of the dura mater. On the other hand, the superficial tenderness associated with referred pain is due to some affection of the brain itself.

But on examining the records of cases of tumour affecting the substance of the cerebrum or cerebellum, a certain number of cases appear in which neither deep nor superficial tenderness were present. Thus we cannot say definitely that if superficial tenderness is absent there is no gross brain disease. On the other hand, the pain and superficial tenderness produced by a tumour that is too large to be excised, will disappear if a considerable portion of the

vault of the skull be removed, as is usual in modern brain surgery. Brisk purgation (with a drop of croton oil) will also ease the pain in cases that have not been trephined.

Thus the referred pain and superficial tenderness cannot depend primarily on the destruction of the brain tissue, but on some condition that can be relieved by extensive trephining or brisk purgation.

Now the only condition that can be relieved by such procedures is heightened tension. Thus I believe that referred pain and its accompanying superficial tenderness of the scalp are due, not to the implication of the brain substance directly, but to the rise of intra-cerebral tension, produced by the destructive process.

We have now reached a useful and necessary distinction between the two forms of pain and tenderness. Local pain and deep tenderness point to an affection of the dura mater, either primary or secondary. Referred pain and superficial tenderness point to a rise of tension within the brain itself.

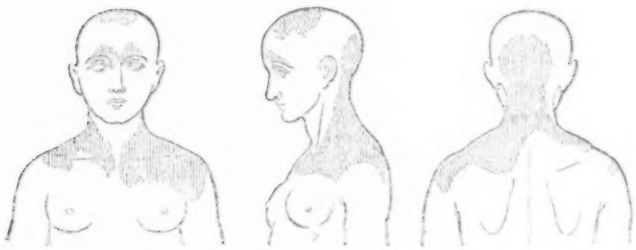


FIG. 45.

To show the areas of tenderness which were present in a case of cyst of the cerebellum (Case No. 45).

Case 45.—Sarah F. (Queen Square, Dr. Tooth), aged 21, single. Admitted August 24, 1892. Died September 18, 1892.

October, 1891. Began to have bad headaches daily. About the same time she began to vomit; headache always better after she vomited.

In about four months both headache and vomiting passed off, but her "head felt turning round," and she was giddy.

About six months ago the headache came on again, with vomiting every few days.

Three months ago the headache had become very severe, and radiated over the back of the head to the shoulders.

October, 1891. Her sight began to fail. This steadily became worse until three weeks ago, when she became blind.

She has never been ill until twelve months ago. Menstruation began at age of 16; every four weeks until the last two months, which have been missed; not painful.

A brother and a sister both have phthisis.

Condition on admission.—Small girl of 21. Dull, expressionless face, except when suffering from pain. No very marked wasting. Pulse 88. Respiration 21. Temperature 98°—99·4° F. (36·7°—37·4° C.).

Mental condition fair, except when she is suffering from an attack of pain.

She suffers from violent attacks of pain in the head, worse on the left side than the right. During the attack she lies on her right side with her head buried in the pillow, crying out with the pain. The pain is most constant in the occipital region, but is also felt over the forehead, temples and vertex, and sometimes extends down the neck to the shoulder. These attacks are associated with vomiting; she feels sick for five to ten minutes before the vomiting occurs. The pain is less severe after she has vomited.

In between the attacks the back of her head and neck show superficial tenderness over an area of varying extent. This tenderness is increased by an attack (fig. 45), and is frequently found to extend over the occipital, sterno-mastoid and sterno-nuchal areas.

Any movement towards the erect position at once brings on an attack of pain. She cannot even lie on the left side without inducing an attack.

She stands with the feet wide apart and the knees bent. If the heels are placed together she reels and falls, more towards the right, but also backwards or forwards. Her walk is a shuffle with the knees bent, and she cannot walk without support. All movements of the legs well and strongly performed. No paralysis.

Grasp—right 50, left 30, on an exceedingly weak dynamometer. Considerable inco-ordination of the right arm, less in the left. Cannot touch the tip of her nose at all easily with right hand. No paralysis of arms or hands.

No alteration of sensation.

Knee-jerks present on both sides but somewhat diminished. No ankle clonus. Plantar reflexes brisk. Abdominal reflexes good.

Smell and taste are good. Hearing poor—watch heard 8—9 inches from both ears.

Vision—right and left can see fingers but cannot count them; can tell light from darkness.

Right eye—optic disc considerably swollen and pale, surface seen well with + 7D.; general hypermetropia + 3D.

Left eye—swelling and hypermetropia same as in right eye. Edge of disc ill-defined. Numerous roundish soft-edged dots arranged in groups between the macula and optic disc.

No ptosis or ocular paralysis. Marked nystagmus on looking to left or right. Occasionally, especially when looking down, there is a tendency to rotatory nystagmus.

Sensation of face good.

No paresis of muscles of face. Masseters act well.

Tongue comes out straight.

Palate moves fairly well.

Sphincters normal.

No cough or expectoration.

No abnormal physical signs in the chest.

Appetite is bad, but she takes her food fairly well, though quite without relish. She does not vomit except with the headache, and not always with every attack. Bowels confined.

Abdomen normal. No tenderness, superficial or deep. Lower edge of liver and spleen not felt.

Urine 1020 sp. gr.; acid; no albumen.

September 11. Attack this afternoon, in which she vomited almost immediately. During the attack the scalp was tender; but seven minutes after she vomited there were only a few remains of the tenderness in the occipital region. She says the pain may last for twenty-four hours if she does not vomit. Pulse becomes very feeble in these attacks. Respiration 40.

September 18. She died in an attack.

Post-mortem.—The brain was soft and removed with difficulty. The cerebellum was adherent on both sides to the brain. In attempting to separate them a rent was made in the upper wall of the right lobe of the cerebellum. From this rent gushed clear straw-coloured fluid. The whole of the right lobe was excavated by a large smooth-walled cavity. Only at one point was anything found suggesting new growth. This was some gelatinous looking material with blood vessels at the upper and outer corner. The brain showed no abnormality except great distension of the ventricles.

No abnormality in any other organ of the body or head, except the eyes.

In the large majority of cases I think it is impossible to say whether the rise of tension be in one part of the brain or in another. However, in most cases of cerebellar tumour the superficial tenderness lies over the occipital areas, and has a great tendency to affect the areas of the neck (third and fourth cervical). This affection of the neck is uncommon in the cases of tumour of the cerebrum. In cerebellar disease the superficial tenderness is more persistent in the occipital

regions than elsewhere. It appears there earlier and disappears later than anywhere else on the scalp. Moreover, the pain has a tendency to be situated below the occipital protuberance, and hence to dart through to the fronto-nasal and mid-orbital regions, both of which may be tender. On the other hand, in the rare cases where we have reason to suppose that the rise of tension is mainly in the lateral ventricles, the referred pain lies mainly in front of a vertical line from ear to ear (Case 43). The pain is more persistent over the front of the scalp, and appears earlier and disappears later in that region than elsewhere.

When the disease affects the cerebrum it is frequently impossible to say, from the distribution of the superficial tenderness only, on which side the lesion lies. For on the hypothesis I have just set forth, though the lesion is unilateral, the cause of the tenderness and pain (pressure) is notoriously bilateral.

But by paying attention to the following points I think we may find that referred pain and superficial tenderness become of more help in localising the lesion than has been the case up to the present. (1) What is the position of the maximum tenderness, *i.e.*, where is the tenderness most acute, and on what side are most areas involved? (2) Where does superficial tenderness first appear, and at what spot does it linger longest?

If local pain and deep tenderness are a sign of meningitis, and referred pain with superficial tenderness point to rise of tension in the brain itself, it might be thought that it would be easy to diagnose an intra-cerebral lesion from a general (as opposed to a local) meningitis. This is not so. For a general meningitis mostly infects the base, and thus leads to rise of tension in the brain itself. Thus many cases of general meningitis suffer from marked referred pain and superficial tenderness. The cause is found after death in the great distension of the ventricles, so common in such cases.

Thus to sum up the conclusions to which we have arrived in this section :—

(1) In every case of brain disease we must first decide

whether the pain is local and associated with deep tenderness, or referred and accompanied by superficial tenderness of the scalp.

(2) Local pain and deep tenderness point to some affection of the dura mater in the region of the tender spot. This affection of the dura mater may be due to a local primary meningitis, or may be secondary to the growth of a tumour in the cortex.

(3) Referred pain and superficial tenderness point to rise of intra-cerebral pressure, due either to some destructive lesion in the substance of the brain itself, or to a general meningitis affecting the base. The other symptoms and signs exhibited by the patient make the diagnosis between these two alternatives fairly easy as a rule.

CHAPTER III.

Headaches referred from Thoracic and Abdominal Viscera.

Amongst the ancients it was well known that affections of the thoracic and abdominal viscera were the cause of many headaches. From the earliest times up to the present day, physicians have attempted to determine the position of the different headaches produced by various abdominal and thoracic diseases. Thus we have the "anæmic," "dyspeptic," "rheumatic," and a host of other headaches associated each with its own disease. One observer has gone a step further and classified certain headaches according to the drugs which relieve them, speaking of the headache relieved by acids, by alkalis, or by purgatives. In this way an enormous literature has grown up around the question of the forms of headache associated with visceral disease.

Again, for generations scalp tenderness has been recognised as the accompaniment of certain headaches, and this association finds expression in a popular German term for headache. It has, however, been looked upon more as a curiosity than as a matter for serious investigation.

It soon became evident in the course of this investigation, that the head, like the body, shewed areas of hyperalgesia in connection with the pain produced by diseases of

the eye, ear, and other organs situated in the head itself. The next step was to see whether areas of tenderness on the scalp accompanied the headaches which were known to be produced by diseases of the thoracic or abdominal viscera. It soon became evident that such an association existed with a certain number of such headaches. On the other hand, some were found to be unaccompanied by tenderness of the scalp.

Thus in this section I shall only deal with those headaches produced by lesions of the thoracic and abdominal viscera, that are associated at one time or another with patches of superficial tenderness on the head or neck. I shall entirely neglect all headaches which may be due to visceral causes but are not at any time associated with superficial tenderness of the scalp.

At first I attempted to classify the areas of scalp tenderness according to the thoracic and abdominal diseases in which they occurred. But in this attempt I utterly failed. Meanwhile the material I had gathered seemed to shew that the clue lay in an association of certain areas of the scalp with certain areas of tenderness on the thorax and abdomen. Thus I many years ago associated the temporal area of tenderness on the head with tenderness of the subscapulo-ensiform (seventh dorsal) area on the chest. Further experience proved this association to be correct, and that we must no longer look upon these headaches, associated with tenderness of the scalp, as "anæmic," "dyspeptic," &c., but as a representation of areas of superficial tenderness on the chest or abdomen. Thus, speaking broadly, it is quite immaterial for the production of a temporal headache, with tenderness over the temporal area of the scalp, whether the disease be phthisis destroying the base of the lung, gastritis, mitral disease, or anæmic gastralgia. The only necessity is that any one of these diseases should produce a certain area of cutaneous tenderness on the surface of the body (seventh dorsal).

I must therefore ask pardon of my readers for neglecting the mass of observations which have accumulated around this subject from the earliest times. For in the first place I do not base my conclusions on the situation of the headache

only, but on the position of the accompanying tenderness. Secondly, I do not look upon any particular disease as the determining factor in the position assumed by the headache and tenderness. But I seek to explain its regional distribution by the same factor which determines the position of the correlated pain and tenderness on the surface of the body. This factor is the position of the spinal segment in which the sensory nerves of the affected organ end. Thus the determination of the part of the organ affected and a consideration of the sensory supply of that part is more important than a statement of the general disease from which the patient is suffering. For this reason observations classified according to "dyscrasiæ" are useless for my purposes, and the statement that a headache was due to "cardiac disease" is of no help unless the exact condition of the heart be stated.

The proof that an area on the chest or abdomen is associated with a certain area on the scalp runs on three lines. Firstly, there are certain cases where a single area on the chest or abdomen is accompanied by one area only on the scalp. But, as I pointed out in the first part of this investigation, the appearance of a single isolated area of superficial tenderness on the body is a rarity, of extreme scientific interest but of uncommon occurrence. Much more, then, is it difficult to find cases in which not only one area on the body is present alone, but the appropriate headache is also present, uncomplicated and to its full extent. However, such conditions are occasionally fulfilled, and my experience has enabled me to gather together a fair number of such cases[1] in which one area on the body was associated with one area on the scalp.

The second method, which can be practised every day in the wards, is to notice the effect produced on the scalp tenderness which is already present, by the appearance of a fresh area of tenderness on the body. The want of dia-

[1] For this purpose study of patients in a hospital is absolutely essential. For isolated areas mostly occur at the beginning of some fresh disturbance, or when it has almost passed off. Out-patient practice shows us disturbances in full swing, or the results of an acute disturbance that has passed off. Patients who are suffering from an acute recrudescence of a chronic disease do not come to the hospital till the acute attack is passed.

grammatic accuracy of such observations is compensated by the frequency with which the opportunity occurs for making them.

The third and least reliable method is to watch the effect produced on the areas of the scalp by the disappearance of any area on the body.

To illustrate these three methods let us consider the headache and tenderness associated with the presence of the subumbilical area (tenth dorsal) on the body. Fig. 46 is taken from a case of cardiac failure and the presence of the subumbilical area was due to the rapid enlargement of the

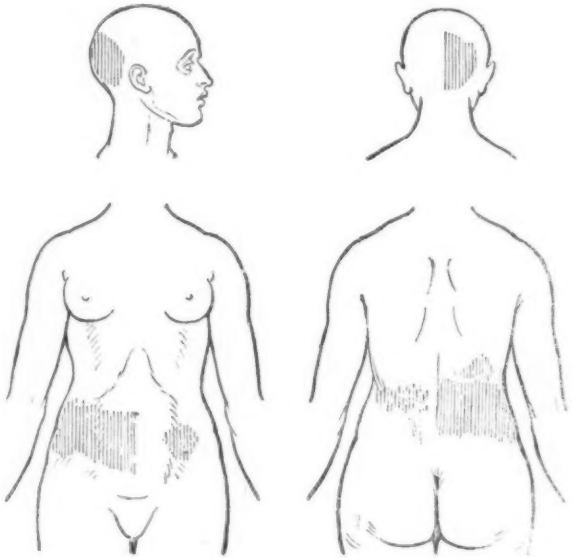


FIG. 46.

To show the association between tenderness over the tenth dorsal area on the body and the occipital area on the scalp (Case No. 46).

liver. The patient had suffered from mitral regurgitation without pain, and had been under observation for two months. The heart then failed, the liver enlarged rapidly, and she began to complain of pain below the umbilicus on

both sides, worse on the right side than the left. With the appearance of this area in the abdomen, she complained of occipital headache, and the scalp was found to be tender over the area in fig. 46.

Case 46.—Sarah S. (Victoria Park, Dr. Eustace Smith), aged 25. Single.

July, 1893. Acute rheumatism. Remained in bed a month and when she got up found that her breath was very short.

September, 1893. Admitted to V.P. Hospital with mitral stenosis and regurgitation.

Apex beat diffuse and forcible. Diastolic apical thrill. Upper limit cardiac dulness, third rib. Right limit, right edge of sternum. Left limit, nipple line. At apex first sound is loud and followed by a systolic murmur conducted as far as the left axilla. Second sound heard at the apex and followed by a short diastolic murmur. The pulmonary second sound was reduplicated. Aortic second sound normal.

Pulse small, irregular, easily compressible.

Edge of liver just felt.

She much improved, and was discharged on December 13, 1893.

As soon as she was discharged she tried to work about the house. Within a few days began to vomit. Much pain in the abdomen and headache.

Readmitted December 29, 1893. Condition as follows:—

Skin of face of a slightly yellowish tinge with a red spot on each cheek. Conjunctivæ not yellow. Ears and lips a little blue. No swelling of ankles. Distinct clubbing of the fingers. Knee-jerks normal. Plantar reflexes brisk.

She cannot lie flat in bed. Very short of breath on the least exertion. No fainting, but frequently feels faint.

She complains of pain in the abdomen below the navel and in the loins; she also has pain "across the shoulders and over the chest below the level of the nipples." Much superficial tenderness.

Headache over the occipital region and over both temples associated with superficial tenderness of the scalp.

Pulse about 84, irregular both in force and rhythm, small stroke, compressible.

Distinct pulsation, but no marked distension of the veins of the neck.

Apex beat in fifth space in the nipple line. Pulsation also seen in third and fourth spaces internal to nipple line. Upper limit of cardiac dulness, third rib. Right limit cardiac dulness, right edge of sternum. Left limit cardiac dulness, outside the nipple line. Heart's action very irregular. With the short beats a systolic murmur only is heard, but when the diastole is prolonged a soft diastolic murmur is heard. The first sound is feeble

at the apex, but can be heard independently of the systolic murmur. The systolic murmur is conducted to the angle of the left scapula. No murmur heard over aortic area. First sound feeble over the right edge of the sternum.

Liver a good 2 inches (5 cm.) below the border of the ribs.

Suspicion of fluid in the abdomen.

Respiration 22. Slight cough; worse at night.

Some crackling sounds heard at the bases of both lungs and at apex of right lung.

Tongue red and a little furred. Bowels opened daily. She frequently vomited undigested food.

She has not menstruated for five months. Usually lasts two days. No pain.

January 9. The feet are swollen to-day and there are distinct signs of fluid in the abdomen.

The liver edge can now be felt just above the level of the umbilicus.

She complains of pain in the abdomen below the umbilicus, and occipital headache.

Marked superficial tenderness of the abdominal wall over the area in fig. 46, with definite tenderness of the occipital region of the scalp.

The liver continued to enlarge and the pulse became very irregular and small. She died on January 20, 1894.

On January 6 the temperature began to rise and oscillated irregularly between 100° and 98° F. (37·8° and 36·7° C.).

The urine was acid, sp. gr. 1025, and contained an amount of albumen which varied from about $\frac{1}{12}$ to $\frac{1}{19}$.

Post-mortem.—No pericarditis. Right side of the heart dilated. Tricuspid orifice admitted four fingers. Pulmonary valves otherwise normal. Left ventricle hypertrophied. Some thickening of the edges of the mitral valve which was somewhat stenosed. The valve was incompetent. Around its base on the auricular surface was a small layer of bead-like vegetations. The aortic valves showed fresh vegetations, which contained streptococci in considerable numbers.

No peritonitis. Fluid in the abdomen.

Liver weighed three pounds six ounces. Congested and fibrotic.

Kidneys congested, but otherwise normal.

Spleen small and congested with small fresh infarct in upper part.

Left lung healthy except for congestion at the base. Right lung congested. In middle lobe was a small infarct with some collapse around it.

Pelvic organs normal. Ovaries showed no sign of recent menstruation.

An exactly similar association between the subumbilical area and occipital headache and tenderness, is shown in

fig. 7. Here the pain was due to intestinal disturbance. The case is reported on p. 356.

In the same way menstruation will frequently produce pain over one or both subumbilical areas, with tenderness in the occipital region of the scalp.

So far we have only sought cases in which the subumbilical area only was tender, and have attempted to show that it may be associated with tenderness over the occipital region. This may be called the direct method. The second, or indirect method, consists in noticing the effect produced on the tenderness already present on the scalp by the sudden addition of the subumbilical area to the tender areas on the abdomen. This sudden advent of the subumbilical area is especially well seen in cardiac cases. For certain of these cases are most difficult to keep at rest, and when allowed out of bed are liable to unduly exert themselves when not under supervision. In such cases the heart may fail sufficiently to cause enlargement of the liver, with pain and tenderness below the umbilicus. Occipital headache and tenderness will frequently then be added to the headache and tenderness, which may be already present on the scalp.

Thus we find that the occipital area on the scalp is associated with such disturbances as produce tenderness over the subumbilical or tenth dorsal area on the abdomen.

The area on the abdomen just above the umbilicus (ninth dorsal) does not commonly appear alone; but I possess a few cases showing the direct association of this area with the parietal area on the scalp. The case I have selected for illustration was one of fibroid phthisis (fig. 6, Case 6, p. 354), in which a fresh outburst took place on the left side, the side opposite to the permanently damaged lung. The left side of the chest and abdomen showed the ninth dorsal fully developed, with the eighth dorsal partly present. On the right side of the chest the maxima of the ninth dorsal only are present. Corresponding to these areas on the abdomen and chest, the parietal area is beautifully shown on the left side of the scalp, with the maximum of the same area on the right side of the head.

We frequently have the opportunity of verifying this relation between the ninth dorsal area and the parietal area on the scalp by the indirect method, in those cases of phthisis where one base is becoming implicated or in those gastric cases where the ninth dorsal becomes added to the two other gastric areas. Under such circumstances we find that the tenderness of the scalp passes back behind the vertical level of the ears coincidently with the addition of the ninth dorsal area to the other areas on the abdomen and chest.

The eighth dorsal area is also one that is rarely seen without admixture with the areas around it. But its head-

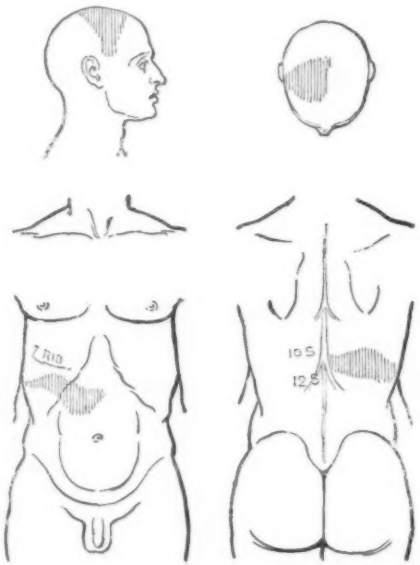


FIG. 47.

To show the association between the eighth dorsal area on the body and the vertical area on the scalp (Case No. 47).

ache is a peculiarly easy one to note, and is the well-known vertical headache of many liver disorders frequently asso-

ciated with tenderness over the vertical area of the scalp. I have selected for illustration (fig. 47) the case of a man who suffered from tubercular phthisis affecting mainly the right side, with active disturbance at the right base. He developed pain and tenderness in the right side, and on one occasion the eighth dorsal area was found to be marked out in a very beautiful manner. With this band of tenderness was associated a tender area on the scalp corresponding to the vertical area.

Case 47.—Charles M. (Victoria Park, Dr. Heron), aged 34. Admitted December 15, 1893.

He has had a cough for some time, especially in the winter. Nine weeks ago he suddenly felt ill, lost his appetite. He went to bed, felt very hot and sweated a great deal. He vomited after his meals and suffered from nausea. During this time he has wasted and suffered from pain across the lower part of the chest.

On admission his condition was as follows :—

Medium sized man of 35. Looks about his age. Lips a little pale and blue. No œdema. Marked wasting of the limbs and coverings. Profuse nocturnal sweating.

Respiration 36, regular, not short of breath as he lies in bed, but short of breath on the least exertion. Cough not very troublesome. Expectoration greenish-yellow. Semi-fluid containing a quantity of mucus. Tubercle bacilli found.

The pain has now passed off, and he now has no headache or tenderness of the scalp.

The movement of the chest is bad. No dulness over apices in front, but the note is markedly deficient over both upper lobes behind as low as about the level of the sixth vertebral spine. At the right apex in front, the breath sounds are just heard and vocal resonance is diminished ; râles heard after coughing. At the left apex in front the breath sounds are scarcely audible and vocal resonance is nearly absent ; a few râles are heard after coughing. Over the right lung behind the breath sounds are hollow and the vocal resonance is increased over the extreme apex, whilst at the level of the spine of the scapula, the breath sounds are cavernous and whispered pectoriloquy is heard. A similar condition obtains over the upper part of the left lung. From the angle of the scapula downwards, on both sides the breath sounds and vocal resonance are feeble, but no râles are heard.

Pulse 100, regular, poor stroke. Artery distinctly hard for a man of 35.

Cardiac dulness is masked. Heart sounds normal. No murmur.

Tongue clean, moist, a little pale. Appetite now fair. He vomits with his cough, but not otherwise.

Liver not felt. No abnormal signs in the abdomen.

Urine 1020 sp. gr., acid. No albumen or sugar.

February 23. Yesterday he began to complain of pain over the right costal border and pain over the right vertex. To-day there is definite superficial tenderness both of the body and scalp as in fig. 47.

His cough is about as before. He is sweating more at night.

The signs at the left apex are quieter and fewer râles are heard.

On the other hand there is now diminution of percussion note over the right base. Below the angle of the right scapula, the breath sounds are very weak, but vocal resonance is increased and numerous râles are heard all over the right base below the angle of the scapula. The left base is free as before. No friction heard anywhere.

Since his admission he has suffered from occasional slight attacks of diarrhœa. The motions became loose two days ago. The pain over the eighth dorsal area does not seem to be affected by the passage of the fluid motions. He now has three motions in twenty-four hours.

His temperature has been irregular and high from the beginning, sometimes touching 102° F. (38·9° C.), but generally reaching the normal in the morning.

The seventh dorsal is one of the easiest areas to associate with its proper headache, owing to the frequency with which the two areas of tenderness appear together. Fig. 48, chosen to illustrate the relation of this area to the temporal area of the head, is taken from a case of anæmia with gastralgia.

Case 48.—Letitia A. (Victoria Park Chest Hospital, Dr. Thorowgood), aged 28, single, cook. Admitted April 24, 1894.

For a long while she has suffered from pain in the left side of the chest and back.

For the last four winters has been troubled with cough. No cough in the summer.

Christmas, 1893, had her usual winter cough, which ceased in January, 1894.

For six months she has been getting thinner, and also steadily paler.

Short of breath for twelve months. Worse the last three months.

No acute rheumatism.

Menstruation began at 13. Regular every four weeks; lasts seven days. Six months ago she would use two diapers on the first three or four days. For the last three months has used scarcely one a day. The discharge is paler than it used to be. She has had no pain on menstruation lately. No vaginal discharge.

No abnormality in her family history.

On admission:—

'Medium sized woman of 28. Face very pale. Forehead and skin of body pale, with a faint yellowish tinge. Lips and orbital conjunctivæ pale. Ankles swell when she walks about. Wasting of neck, upper part of chest and of muscles of extremities. Knee-jerks decidedly increased; equal. No ankle clonus. Plantars obtained with difficulty.

No fainting. No palpitation except on exertion. Very short of breath when she goes up an incline, or upstairs.

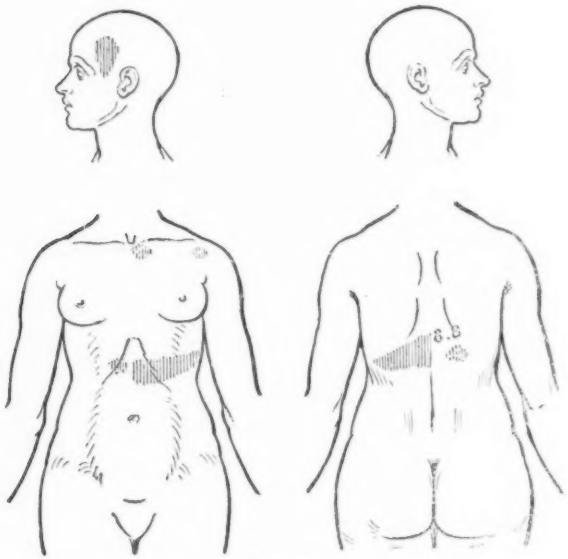


FIG. 48.

To show the association between the seventh dorsal area on the body and the temporal area on the scalp (Case No. 48).

She complains of pain over left lower ribs, in epigastrium and in the back below the angle of the left scapula. It comes on if she has been walking or lifting anything heavy. The pain disappears when she is in bed. Very seldom in right side; practically only in left side.

Headache in left temple. It starts as a very sharp pain in the temple, lasting a short time and followed by a dull aching pain.

Marked and well-defined superficial tenderness on the body and left side of the head over the areas shown in fig. 48.

Pulse 82, regular. Fair stroke. No pulsation in veins of neck. Bruit heard in veins of neck on right side.

Estimation of the blood:—Hæmoglobin 48 per cent. (by Gowers' hæmoglobinometer). Corpuscles 93·8 per cent., or 469 in 10 squares (by Gowers' hæmacytometer).

Apex beat fourth space internal to nipple line. No thrill. Upper limit cardiac dulness, lower border third rib. Right limit, left edge of sternum. Left limit, one inch internal to nipple line. A soft systolic murmur heard over the apex beat, but not conducted with the axilla or upwards. The first sound over the apex is not obscured by the murmur. Accentuated pulmonary second sound.

Respiration 20, regular. No cough. No expectoration.

Movement of right apex a little better than that of left. Percussion note perhaps a little diminished under left clavicle. Distinctly diminished over extreme left apex behind. Over left apex in front breath sounds are harsh and expiration is a little prolonged; vocal resonance not increased. At left apex behind, breath sounds are weak, vocal resonance is diminished, and occasional rhonchus is audible. Elsewhere signs normal.

Tongue moist and a little grey. Appetite variable. Sometimes fairly good. At other times she cannot eat anything.

Sometimes, if she has no pain, food will cause the pain to appear over the pit of the stomach and in the back. If the pain is already present taking food makes it worse. The pain comes on directly she eats or ten minutes after taking food, and if it comes on in the middle of the day (after dinner) it will last till the next morning. If she lies in bed the same diet will hardly cause any pain. If she is up and about, the same food will cause a great increase in the pain that is always present when she is up. No vomiting. Frequent nausea. Bowels open once daily as a rule, without purgatives. Liver and spleen not felt. No physical signs in abdomen.

Urine, specific gravity 1042; acid. No albumen or sugar.

Temperature normal.

As we pass higher up on the chest the areas become in themselves more difficult to mark out, and their correlation with areas on the scalp more difficult to determine. For the third, fourth, fifth and sixth dorsal areas all tend to appear in combination, and if they are present singly they are, as a rule, not fully developed, but represented by their maxima only.

The area of the sixth dorsal is not uncommonly affected in consequence of cardiac lesions, either with or without the seventh dorsal. It is associated with the fronto-temporal

area on the scalp. The case selected for illustration is one of aortic stenosis, and shows the relation between these two areas very beautifully (fig. 49).

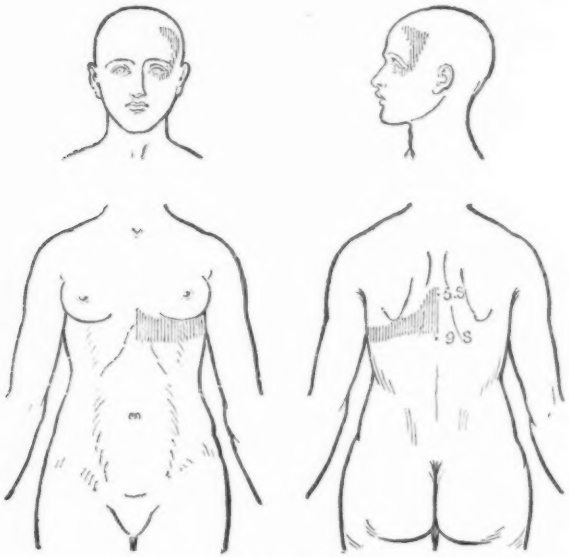


FIG. 49.

To show the association between the sixth dorsal area on the body and the fronto-temporal area on the scalp (Case No. 49).

Case 49.—Elizabeth L. (Victoria Park, Dr. Smith), aged 17.

At the age of 8 years had "rheumatism." Legs, hands, and elbows swelled. At age of 15 had a second attack. Feet, hands and elbows again swelled, and "little growths" came on the elbows and knuckles. Has never been quite well since. Was admitted to V.P. Hospital for morbus cordis, May, 1893. Got worse directly she left the hospital. Much pain. Gradually improved, and was fairly well till December, 1893. Then began to suffer from pain and "irregular action of the heart."

Re-admitted, March 2, 1894. Condition as follows:—

Medium-sized girl of 17. Well-developed; looks much older. Face of a uniform pinkish colour. No cyanosis. No flush on cheeks. No wasting. Knee-jerks normal. Plantar reflexes good. No fainting. Palpitation on the least exertion. Heart beats irregularly. Can walk slowly on level ground, but when she goes

upstairs has a feeling of suffocation as if she could not get her breath. Heart thumps against the chest and she feels faint.

She always has pain to a greater or less extent under the left breast going through to the angle of the scapula behind. At other times she has pain over the upper part of the chest on the left side and in the left arm to the elbow.

Troublesome headache "in the temples."

Pulse 80, regular, small stroke; not a regurgitant pulse. No pulsation of the arteries or veins of the neck.

Apex beat in fifth space one and a-half inches (4 cm.), outside nipple line. Upper limit of cardiac dulness second space. Right limit, close to right edge of sternum. Left limit, left nipple line. Over the right base a systolic murmur is heard conducted over the sternum and heard over the apex beat. The murmur over the apex beat does not obscure the first sound and is probably the same as that over the right base. Over the lower part of the sternum a slight but distinct diastolic murmur is heard. The systolic murmur is not heard in the left axilla or at the angle of the left scapula. Diastolic murmur not heard at the apex. Sounds on right side of heart good.

Liver not enlarged. No œdema or ascites.

Respiration 20. No cough. No abnormal physical signs in the lungs.

Urine sp. gr. 1018. No albumen.

When admitted she was in the third day of menstruation and thus the pain and tenderness were wider spread than usual. She soon settled down to the usual pain under the left breast and upper part of left side of chest and arm associated with superficial tenderness.

March 27. The pain and tenderness in the body and head has been steadily diminishing under the influence of rest in bed, and to-day the only remains consist of very slight pain under the left breast associated with a band of tenderness and fronto-temporal headache accompanied by tenderness over the fronto-temporal area of the scalp (fig. 49).

The pulse is 70, and the heart's action is quieter, but otherwise the signs remain as before.

Finally all pain and tenderness disappeared, but reappeared for a short time after she had attempted to run upstairs.

The eyes were normal. Nothing in disc, fundus, or media. Vision: right eye, $\frac{6}{9}$; left eye, $\frac{6}{6}$; Jäger 1 in both. Hearing, smell, taste, good. Nothing abnormal in ears, nose, or pharynx.

Temperature throughout normal. Highest 99·6°, on one occasion.

The relation of the sixth dorsal area to the fronto-temporal area of the scalp is best seen by the indirect method. Thus we repeatedly find that the addition of the sixth dorsal area to the seventh dorsal adds the fronto-temporal to the

temporal area previously present on the scalp. In a case of mitral obstruction and regurgitation it was interesting to see how the fronto-temporal area faded away as the sixth dorsal diminished, whilst at the same time the temporal area increased as the seventh dorsal became more evident.[1]

The fifth dorsal area is exceedingly difficult to obtain pure, and in several of my cases in which it has appeared alone, the headache was not developed or only faintly marked. This area on the body seems, however, to be associated with

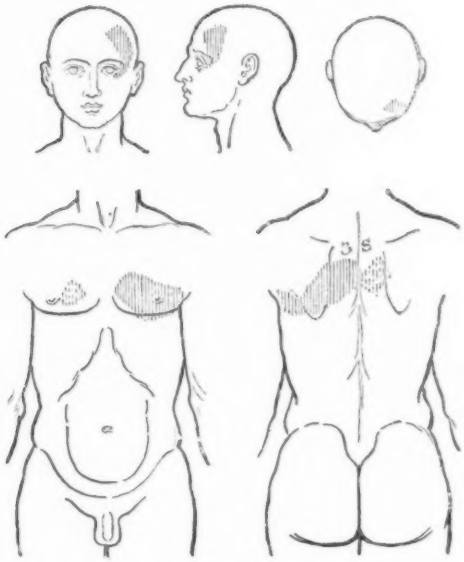


FIG. 50.

To show the association between what I take to be the fifth dorsal area on the body and the fronto-temporal area on the scalp (Case No. 50).

the fronto-temporal area on the head. In Case 50 (fig. 50) the fifth dorsal area was present on the left side of the chest,

[1] This case will be published in full in my paper on "Mental States in Visceral Disease."

and was associated with the fronto-temporal area on the left side of the forehead.

By the indirect method we repeatedly see hyperalgesic areas with the characteristic upper border of the fifth dorsal, associated with tenderness on the head, which is bounded in front by the equally characteristic anterior border of the fronto-temporal area.

For the first time, in passing from below upwards, we have come to two areas on the chest, which are associated with the same area on the scalp—a condition which we shall find repeated in all the areas above this level on the chest.

Case 50.—Edward S. (Victoria Park Chest Hospital, Dr. Thorowgood), aged 36. Married. Tea porter. Admitted May 2, 1894.

Cough every winter for the last six to seven years. It comes on as soon as the bad weather sets in, and passes off with the winter.

January, 1893. Had a bad attack of "bronchitis," and has never been well since. Has had a cough and has spat phlegm ever since.

Since January, 1894, he has sweated at night and lost much flesh.

No hæmoptysis.

History of phthisis in the father's family, but not amongst brothers and sisters.

On admission :—

Tall man of 36. Face and lips a fair colour. No anæmia. No œdema of face or ankles. No cyanosis. No clubbing of fingers. Some wasting, showing itself mainly in the diminution in his well-developed muscles. Knee-jerk and plantar reflexes normal.

Respiration 18. Short of breath on exertion. Not as he lies in bed. Cough troublesome at night. Very little expectoration (no tubercle bacilli could be found on two examinations).

He complains of pain in the left nipple. Sometimes this goes through to his shoulders, and hurts him when he breathes or coughs. Marked superficial tenderness as in fig. 50.

He says : "I suffer from no headache, but from constant soreness of the scalp." He cannot put his hat on, his head is so tender. Marked superficial tenderness as in fig. 50.

At the apices the movement is about equal, but the right base moves better than the left. In front there is a little diminution of percussion note under right clavicle, but behind the note is distinctly diminished over the left apex and mid-scapular region. Breath sounds and vocal resonance fair under both clavicles. A few râles at both apices. Behind breath sounds fair, but expiration prolonged and vocal resonance diminished over left apex. In

left mid-scapular region expiration prolonged and vocal resonance increased. At left base breath sounds fair and vocal resonance about normal. A few râles are heard all down the left back, especially about angle of left scapula. Not at extreme left base. No friction anywhere.

Pharynx somewhat red. Larynx absolutely normal.

Pulse 60, regular, good tension.

Physical signs in the heart normal.

During his stay in the hospital he was frequently troubled with pain and superficial tenderness over a variable area in the left side of the chest, mainly in the region of the fifth and sixth dorsal. Frequent fronto-temporal headache.

When he left hospital pain was improved and chest was much freer of râles. Other physical signs as before.

His temperature was never higher than 99·4° F. (37·4° C.) He gained $7\frac{1}{2}$ lbs. in six weeks.

It is difficult to decide what tenderness of the scalp is associated with tenderness over the fourth dorsal area on the body. My observations give apparently contradictory results, for sometimes I find this area apparently associated with the fronto-temporal, at other times with the mid-orbital area of the scalp. I must, therefore, leave undecided whether the fourth dorsal area on the body is associated with the fronto-temporal or mid-orbital area on the scalp.

The third dorsal area appears to be definitely associated with the mid-orbital area on the scalp (fig. 51).

Case 51.—Margaret R. (Victoria Park Chest Hospital, Dr. V. D. Harris), aged 21, single, dressmaker. Admitted March 20; died April 15, 1894.

She has always been "delicate" and subject to coughs and colds.

Twelve months ago she had a sore throat; since then she has had a constant cough.

September, 1893. She began to spit up small quantities of fluid blood; phlegm remained streaked for some time afterwards. Has frequently had slight hæmoptysis since then.

Summer 1893, attacks of diarrhœa. Attacks on and off ever since.

Has sweated at night for the last six months.

Marked family history of tubercular disease (mother).

On admission:—

Face long and thin. Complexion of a chalky whiteness, with a slight pink flush on the cheeks. No cyanosis. No œdema of

face or ankles. Extreme general wasting. Marked sweating. Knee-jerk and plantar reflexes good.

Respiration about 40. Very short of breath even when lying in bed. Cannot walk more than a few steps. She becomes extremely short of breath after coughing.

Cough frequent. Small groups of single coughs. Not paroxysmal.

Small quantity of irregular masses of muco-purulent expectoration.

She complains of pain in the upper part of right axilla, in the right shoulder and upper edge of right shoulder blade, also in right side of abdomen below the umbilicus and in the right loin.

Headache over anterior part of temples, in the temporal region, and over the vertex.

Marked superficial tenderness of chest and back. Tenderness of scalp.

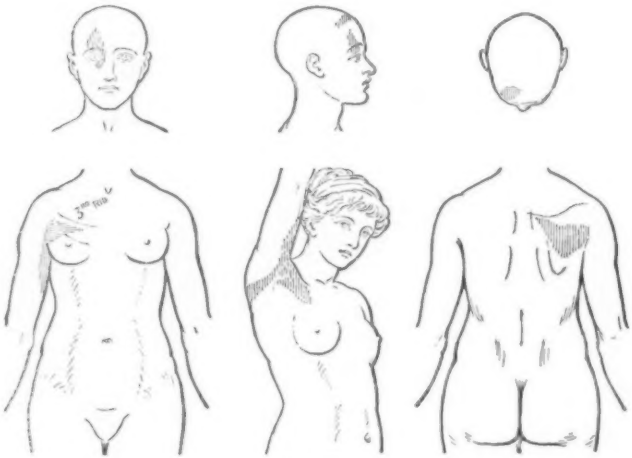


FIG. 51.

To show the association between the third dorsal area on the body and the mid-orbital area on the head (Case No. 51).

Movement of left apex greater than right. Diminished percussion note over apices behind and over both mid-scapular fossæ as low as angle of scapulæ on both sides. Cavernous breathing and whispered pectoriloquy over upper part of right lung in front as low as fourth space. Cavernous breathing and whispered pectoriloquy over a more limited area at left apex in front. Behind cavernous breathing and whispered pectoriloquy at both apices as

low as level of fourth dorsal spine. Râles over front of chest both sides. Behind, râles as low as angle of scapula on left side, and to base on right side. No friction heard anywhere. Pulse 120, low tension, regular.

No abnormal physical signs in heart.

Tongue clean, moist, of a fair colour. Appetite good. No vomiting. No diarrhœa now.

Urine sp. gr. 1020; acid. No albumen, no sugar.

The pain and superficial tenderness was usually wide spread, but on April 1 she had less pain, and the tenderness happened to lie only over the areas in fig. 51. This in no way represents her usual pain and tenderness, which was wide spread as a rule.

Vision: right eye; $\frac{6}{12}$, Jæger 1. Left eye, $\frac{6}{18}$; Jæger 1.

Disc and fundus oculi normal. Slight myopia (about 1D. in the left eye.

The temperature ranged between 102° at night and about 98° to 99° in the morning (about 39° to 36·7° C.).

She gradually became worse and died on April 15.

The second dorsal area, with its characteristic flap on the inner side of the arm, seems to be associated with the mid-orbital area of the scalp. This association is fairly easily determined owing to the prevalence of the second dorsal area in certain forms of aortic disease.

Thus, at least two areas on the chest are more or less associated with tenderness over the mid-orbital region of the scalp. But before this relation can be established each case must be carefully examined for hypermetropia. For, as I pointed out on p. 395, hypermetropia is peculiarly associated with tenderness over the mid-orbital area of the scalp. Case 52 has been chosen to show the method of procedure in such cases, and to illustrate the reasons which led me to think that the headache and tenderness of the forehead were due to the aortic disease, and not to the hypermetropia. First of all, the headache and tenderness were determined, and then, without in any way altering the daily length of time for which she was allowed out of bed, the eyes were put heavily under atropine. At the end of four days the headache was no better. Then she was kept strictly in bed, and the headache and tenderness disappeared. When she was again allowed up headache and tenderness reappeared, but again disappeared when she

was put to bed. Thus, in this case, I think the mid-orbital headache and tenderness was associated with the cardiac condition (producing pain over the second dorsal) rather than with the hypermetropia.

I possess other cases illustrating this association between the second dorsal area on the body, and the mid-orbital on the forehead, in which hypermetropia was absent, but I have quoted this instance to illustrate an attempt at differential diagnosis in such cases.

When the mid-orbital area on the forehead is tender from some thoracic disease, the patient will complain that reading or sewing is painful, although hypermetropia is absent. Thus, at one time a patient suffering from pulmonary or cardiac disease will be unable to do near work without pain, whilst within a short time the headache may have shifted its position, and no longer occupy the mid-orbital area, and reading or near work will no longer increase the headache.

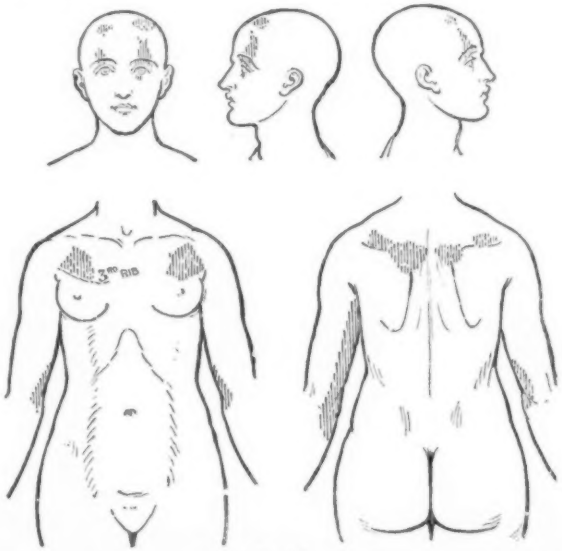


FIG. 52.

To show the association between the second dorsal area on the body and the mid-orbital area on the scalp (Case No. 52).

Case 52.—Edith B. (Victoria Park Chest Hospital, Dr. Heron), aged 13.

Admitted March 20; discharged May 22, 1894.

Just before Christmas, 1893, she had an attack of rheumatic fever. Ankles and knees were swollen and painful, wrists swollen but fingers were not affected.

Since this attack she has been short of breath, and has suffered from pain in the upper part of the chest with bad headache over the eyes.

Nothing of importance in the past or family history.

On admission:—

Small girl of 13, exceedingly intelligent and bright. Lips a fair colour. No cyanosis; no anæmia; no wasting. Knee-jerks and plantar reflexes good.

No fainting. Palpitation on exertion, which is accompanied by pain. Very short of breath on exertion but not when quiet or in bed.

She complains of pain over the upper part of the chest which goes down the left arm to the elbow.

Headache over the eyes and temporal part of the forehead on both sides, worse on left than right side.

Marked superficial tenderness both of chest and scalp.

Pulse 80, regular, medium stroke; fair tension between the beats. No pulsation either of arteries or veins of the neck.

Heart's apex beat in fifth space one inch outside nipple line. No thrill. Upper limit cardiac dulness in second space. Right limit, right edge of sternum. Left limit as far out as half an-inch to left of left nipple line. Over the apex the first sound is short and sharp, and is followed by a soft high-pitched systolic murmur. This murmur is heard at the angle of the left scapula. The second sound at the apex is sometimes reduplicated, and a distinct rough pre-systolic murmur is occasionally audible. Over the right base the first sound is audible, but second sound is a little weak and thin. Over the right edge of the sternum and over the second right space a systolic murmur is heard, differing in tone from that at the apex. It is apparently distinctly separated by an interval from the apical systolic murmur. The pulmonary second sound is accentuated over a wide area. The first sound to the right of the lower part of the sternum is long and low pitched.

No cough. No expectoration.

No abnormal physical signs in the lungs.

Tongue moist, papillæ a little prominent. Appetite poor. Occasional nausea. No vomiting. No pain after food. Bowels confined.

Liver and spleen not enlarged. No signs of fluid in the abdomen.

Vision: right eye, $\frac{6}{9}$; Jæger 2, badly. Left eye, $\frac{6}{\frac{6}{4}}$; Jæger 3.

Hypermetropia in right eye, + 2D. in one meridian; + 2·5D.

in the other. Left eye + 2·5D. in one meridian; + 3D. in the other.

She was put strictly to bed, and the pain and tenderness on the chest and arm practically disappeared. The tenderness on the scalp diminished to a small spot over the left eyebrow.

April 10. She was allowed up and romped and played until she was forced to cease owing to the reappearance of pain. Tenderness had returned in the evening over the areas of the second and third dorsal, including the ulnar side of the arm.

The apex beat is at least half-an-inch outside the nipple line, and forcible.

April 11. The pain is nearly gone, and the tenderness is reduced to two small faint patches, one situated over the second space, and the other over the vertebral border of the spine of the scapula.

The apex beat is now in the nipple line, half-an-inch internal to the spot marked permanently on the skin last night.

She then remained in bed till April 15. Dr. Carter then allowed her to get up, after making careful observations on the condition of the pain and tenderness, and of the physical signs.

The result (fig. 52) was identical with that on April 10.

From this time she was allowed to get up for part of each day, but her eyes were put deeply under atropine. Vision then became in right eye, $\frac{6}{60}$; left eye, $\frac{6}{60}$. The estimated error of refraction rose in the right eye to + 4D., in the left eye to + 6D. all round.

The headache and tenderness of the scalp remained quite unaltered.

May 1. She was again put back to bed, and all pain and tenderness both in the body and head disappeared.

She then remained in bed for thirteen days, and during this time headache over the mid-orbital region was absent.

The first dorsal area is very rarely present except in affections of the aorta, such as aneurism. In these cases it is not associated with any headache or scalp tenderness.

We have now reached that part of the arm which does not become directly tender in visceral disease (the upper gap).

Above the gap there are two areas, the third and fourth cervical (sterno-mastoid and sterno-nuchal) which are associated with tenderness on the head. Pain and tenderness over either of these areas is associated with pain and tenderness over the fronto-nasal area. Thus, if the third cervical (sterno-mastoid) be affected the patient complains that the pain shoots from the back, through the head to the

centre of the forehead (*cf.* p. 433). He places his hand just below the occipital protuberance, and then points to the centre of the forehead just above the root of the nose.

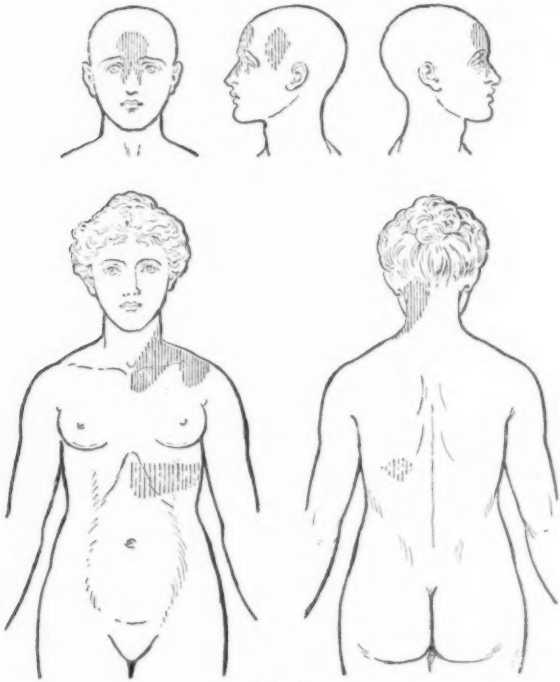


FIG. 53.

To show the association between the third cervical area (somatic) and fronto-nasal area of the forehead (Case No. 53).

This figure also shows the relation between the seventh dorsal area on the body and the temporal area on the scalp (*cf.* fig. 48).

Case 53.—Louisa S. (Victoria Park Chest Hospital, Dr. Eustace Smith), aged 29, married. Admitted April 17, 1894.

At the age of 7 had "rheumatic fever," and was in St. Bartholomew's Hospital for three months.

Since then she has had frequent attacks of acute rheumatism, the last of which was in May, 1893.

Ever since an attack of rheumatism at the age of 18 she has been short of breath, and suffered from more or less pain "under the left breast."

Since she was a girl she has been subject to "fits." Sometimes she has been free of them for years, at other times they occurred once or more in the week. She says they are always present "when her heart is bad."

She had no fits during her stay of six weeks in the hospital.

On admission :—

Medium sized woman of 29. Cheeks a little blue. Lips red with a slightly blue tinge. No œdema of face or ankles. No wasting.

No fainting. Palpitation on the least exertion, followed by pain under left breast; very short of breath on exertion.

Marked pain at epigastrium and under left breast. Headache over temples; marked superficial tenderness.

Pulse 64, regular. The artery is distinctly full between the beats. Arterial wall not hard. No pulsation in the neck.

Apex beat in fifth space just internal to left nipple line. Not heaving. Marked long diastolic thrill. Upper limit cardiac dulness, lower border third rib. Right limit, left edge of sternum. Left limit, slightly internal to left nipple line. Over the apex the first sound is short and sharp. It is followed by a systolic murmur which is not heard at the angle of the left scapula. The second sound is good. After the second sound comes a long trickling diastolic murmur; then, under ordinary circumstances, a little roughness may be heard before the first sound, but nothing beyond. If, however, she is made to move about, a rough, churning, pre-systolic murmur is heard running up to the first sound. Over the left base the second sound is exceedingly sharp and slapping. Over the right base the sounds are good. Over the right edge of the lower part of the sternum the first sound is weak, but the second sound is sharp.

Respiration 20. Very slight cough. No expectoration.

A few râles are heard at the bases of both lungs, especially of the left.

Tongue clean. Appetite fair. Pain directly after food at the epigastrium. Occasionally vomits. Pain relieved by vomiting. Bowels confined.

Liver can just be felt below the costal margin. Spleen not felt. No signs of fluid in the abdomen.

Motion normal.

Sensation normal except for the tenderness above-mentioned.

Cranial nerves normal. Pupils react to light and accommodation.

Knee-jerks equal. No ankle clonus. Plantar reflexes good.

Vision, right eye, $\frac{6}{36}$; Jæger 2, far point $4\frac{1}{2}$ inches; left eye, $\frac{6}{12}$; Jæger 1, far point $10\frac{1}{2}$ inches.

Considerable myopic astigmatism in the right eye. Left eye nearly emmetropic.

Disc and fundus normal.

Hearing good. No abnormality in ears.

Smell good. No abnormality in nose.
Taste good. No abnormality in pharynx or larynx.
Temperature remained about 99°.
Urine sp. gr. 1020; acid. No albumen. No sugar.
April 20. She was suffering from pain in the left side of the neck and at the epigastrium and "under left breast."
Headache "over the front of the forehead" and in the left temple. She says the pain shoots through from the back of the neck to the front of the forehead.
Definite superficial tenderness over the areas in fig. 53.
She got up yesterday for the first time.
Tongue clean. No nausea. No vomiting.
Pulse 70, regular.
Physical signs in the heart as above.

Above the third cervical (sterno-mastoid) area there is no association between the lateral areas of the head and neck, and tenderness of the scalp or forehead. Thus, neither the superior laryngeal nor hyoid areas, nor any areas of the same series are directly associated with pain or tenderness in the region of the scalp or forehead.

I began to describe the relation between areas on the body and areas on the scalp, by pointing out that the presence of the tenth dorsal was frequently associated with the presence of the occipital area on the head. When we pass below the tenth dorsal to those cases in which the pain and tenderness is situated over the eleventh dorsal or any lower area, we no longer find that the pain and tenderness on the body is accompanied directly by pain and tenderness in the head. Thus, in the following case (Case 54) of malignant disease of the cervix, although the eleventh and twelfth dorsal areas were tender, and in spite of the fact that the patient was far advanced in phthisis, she remained free from referred headache and tenderness of the scalp to the end. Again, I watched a case of salpingitis for six weeks, and although she suffered from marked pain and tenderness over the eleventh and twelfth dorsal areas, she did not complain of headache, and no tender areas were present on the scalp. Thus I believe that the abdominal organs (such as the ovaries, testes, liver and greater part of

the midgut), which refer on to the area of the tenth dorsal segment, are associated with referred pain and superficial tenderness on the scalp. On the other hand, the pelvic viscera (Fallopian tubes, uterus and bladder), which refer on to the eleventh dorsal area or on to areas below it, are not directly associated with any referred headache or scalp tenderness.

I must here warn my readers from supposing that they will never find referred headache and tenderness in cases where the uterus or Fallopian tubes are at fault. For as is well-known[1] such cases are peculiarly liable to the development of pain and tenderness elsewhere than over the areas directly in connection with the organs themselves. Cases of cervical catarrh or erosion frequently develop gastralgia with pain after food, occasionally accompanied by vomiting. Under such circumstances headache and scalp tenderness may appear but will represent the gastric areas of tenderness, and obey the rules I have laid down above. Thus, if the original pain and tenderness lie below the level of the tenth dorsal area, any headache and scalp tenderness that may be present will not be correlated with the primary tender areas but with some secondary areas above the lower limit of the tenth dorsal.

Case 54.—Jessie B. (Victoria Park Chest Hospital, Dr. Heron), aged 23, married. Admitted January 17, died January 28, 1894.

February, 1892. "Fell" with her second child. Had attack of "bronchitis," followed by persistent cough, sweating and loss of flesh.

September 6, 1892. Confined. Fifteen days afterwards fainted. Went to bed for a month. Cough. Much wasting and sweating.

Began to bring up blood twelve months ago, and has had slight hæmoptysis many times since.

On admission:—

Much wasted. Face pale and wasted, with occasional brilliant red flush on both cheeks. Ears blue. Profuse sweating at night.

Respiration 40. Very short of breath as she lies in bed. Cough very troublesome. Large quantity of muco-purulent expectoration in nummulated masses. On the night of admission it contained a small amount of blood.

No pain or tenderness of any area above the umbilicus.

[1] *Cf.* Part i. of this work—BRAIN, 1893, p. 106.

Marked superficial tenderness just above Poupart's ligament on the left side, and in the femoral triangle. Tenderness behind, over the lower lumbar region. This tenderness marked out the areas of the eleventh and twelfth dorsal segments on the left side, with the maxima of the eleventh dorsal on the right side.

No headache. No tenderness of the scalp.

Signs of extreme cavitation over the whole of the upper part of the right lung. The right side is dull from apex to base. Over the left lung bronchial breathing and bronchophony were heard everywhere, with occasional small areas of tubular breathing, and whispered pectoriloquy. Râles all over the chest.

No abnormal physical signs in the heart.

Tongue furred and dry. Appetite fair. Bowels irregular. No pain after food. No vomiting.

Liver and spleen not felt. Nothing abnormal felt in the abdomen.

No vaginal discharge now. She has not menstruated for many months. Menstruation began at 13. Regular, with an interval of three weeks. Lasted as a rule six days. About two to three diapers daily. Much pain in the back for a day or two before, and during the flow. First child, December, 1890. Nine hours in labour. Instruments used. Milk came in on third day. Got up on tenth day. Suckled child for eleven months. Second child, September, 1892 (*Vide supra*). Occasional yellowish discharge. No blood-stained discharge apart from menstruation.

On examination *per vaginam* a mass is felt in the cervix, either an erosion or a growth. Uterus not enlarged.

Temperature sometimes reached 102° and never fell to normal.

Urine sp. gr. 1030, acid. No albumen or sugar.

At first she much improved, and was bright and cheerful. Pain and some tenderness over the areas of the eleventh and twelfth dorsal was frequently present.

On January 28 she got suddenly worse, and died in a few hours.

Post-mortem.—Right lung: Whole upper lobe one large cavity, containing pus and *débris*, lower and middle lobes much scattered tubercle. Fibrosis. Left lung: Much fibrosis of both lobes. Scattered tubercle and two small cavities.

No ulceration of the intestines, no peritonitis.

Tubes and ovaries normal.

Around the cervix and in its substance is a growth. Mucous membrane raised, roughened and in part ulcerated. The growth affects the lower end of the cervical canal. Microscopical examination showed involution cells (cancer).

Within the area between the third cervical (sterno-mastoid) and the tenth dorsal segments, pain and superficial

tenderness may occur without headache or scalp tenderness. But such pain and tenderness is usually transient or slight. Should the tenderness persist for any length of time or be severe, the proper scalp tenderness will sooner or later make its appearance. As the visceral disturbance dies away the headache and scalp tenderness usually disappear before that on the body, just as it tends as a rule to appear later than the somatic tenderness with which it is associated. In a few cases, however, the headache and scalp tenderness may be in excess of the pain and tenderness on the body. I am unable as yet to say on what this depends.

The maximum tenderness on the scalp, in connection with tenderness over the dorsal areas, is on the same side as the tender area on the body. It is, however, not uncommon to find a tender area on one side only of the body with not only tenderness on the same side of the scalp, but also some less marked tenderness over the same area on the opposite side of the head. Thus, a visceral lesion on one side of the body seems to more readily cause bilateral tenderness on the scalp than on the body. The tenderness on the opposite side to the lesion comes later, disappears earlier, and is less fully developed than that on the same side as the lesion.

Before concluding this section I must allude to certain peculiarities of the third and fourth cervical areas (sterno-mastoid and sterno-nuchal). That they should become tender in diseases of the apex of the lung is not to be wondered at. But these areas also bear a curious relation to affections of certain abdominal viscera, notably to the stomach and liver. In certain diseases of the stomach we not only find that one or more of the gastric areas (seventh, eighth, or ninth dorsal) become tender, but that frequently one or other of these two cervical areas is tender in addition. Under such circumstances there may be temporal tenderness accompanying the dorsal area, and frontal tenderness accompanying the cervical area (fig. 53, Case 53). A similar condition frequently obtains in various disturbances of the liver.

I have expressed the conclusions to which we have arrived in this chapter in the following table.

Area on Body	Associated Area on Scalp.	Organs in particular relation with these areas.
Cerv. 3	Fronto-nasal (? rostral)	Apices of lungs. Stomach. Liver.
Cerv. 4	Fronto nasal	Aortic orifice (?)
Dorsal 2	Mid-orbital	Lung. Heart (ventricles). Ascending arch of aorta.
Dorsal 3	Mid-orbital	Lung. Heart (ventricles). Arch of aorta.
Dorsal 4	Doubtful	Lung.
Dorsal 5	Fronto-temporal	Lung. Heart (occasionally).
Dorsal 6	Fronto-temporal	Lower lobe of lungs. Heart (auricles).
Dorsal 7	Temporal	Bases of lungs. Heart (auricles). Stomach (cardiac).
Dorsal 8	Vertical	Stomach. Liver. Upper part of small intestine.
Dorsal 9	Parietal	Stomach (pyloric end). Upper part of small intestine.
Dorsal 10	Occipital	Liver. Intestine. Ovaries. Testes.
Dorsal 11	O	Intestine. Fallopian tubes. Uterus. Bladder (contraction).
Dorsal 12	O	Intestine (colon). Uterus, &c.

I am aware that the statements I have made in this chapter will probably have to undergo considerable amendment in course of time. I hope, however, that the main outlines of the relation between certain referred pains in the body, and certain referred headaches may be found to be correctly stated in this chapter.

CHAPTER IV.

§ 1. *Parts which do not cause referred pain.*

Throughout this paper I have neglected all such headaches as were unaccompanied by superficial tenderness. I have also pointed out, when considering the pain produced by diseases of each organ of the head and neck, that certain of the pains so produced were local and not referred. It is instructive to collect these local pains into a group and to consider their causes.

Firstly, there are certain parts which do not cause referred pain because they belong to the surface lining of the body. Such parts are the conjunctiva, the epithelium on the anterior layer of the cornea and the external auditory meatus. Such structures are in reality parts of the skin, and, when injured, no more cause referred pain than the skin of the body. The external auditory meatus not only does not cause referred pain, but is actually a part on to which pain is referred (the ear maximum of the hyoid area).

A second group of structures, which tend to cause local and not referred pain, accompanied by local and deep tenderness, is formed by the external lining of the organs of the head. Thus the periodontal membrane of the teeth does not usually cause referred, but local pain and tenderness (p. 409). The dura mater in the same way, when diseased at one spot, causes local pain over that spot associated with deep tenderness (p. 430).

Thus, here again in the head as in the body, we find that disease of the parietal lining membrane, whether external or internal, does not as a rule cause referred, but local pain accompanied by deep tenderness.

§ 2. *Megrim.*

I now reach a portion of my subject which will, I fear, run counter to the teaching of many. For I have placed megrim amongst those pains in the head which are not referred and which bear no relation to disease of organs of the head.

Of late the word megrim has been used in an exceedingly loose manner to denote almost any form of headache that is associated with vomiting.

But the megrim that has been so brilliantly described by eminent scientists [1] from observations on themselves, is a perfectly definite disturbance, differing in its course and symptoms from almost every other form of headache. The introduction of eye headaches, neuralgias, headaches referred

[1] Airy, Du Bois Reymond and others.

from the stomach, and their like, into the same group as megrim has only confused and obscured one of the most definite groups of symptoms in medicine.

I propose, therefore, to use the word "megrim" solely for a headache presenting the following characteristics. It occurs in those engaged in intellectual work.[1] It frequently begins with a profound visual disturbance such as scotoma, hemiopia or the "fortification figure." This is followed by an intense, more or less localised, headache, which slowly reaches a certain intensity and then frequently culminates in violent vomiting.

Now, this group of symptoms is so characteristic and has been so well observed that the text-books of medicine contain practically all that is to be said about the course and surroundings of this affection.

But most authorities look upon some of the headaches they class with megrim, as due to some affection of the eyes, teeth, &c.

Now, I have pointed out throughout this paper, that a referred headache is caused by irritation of some organ, and this irritation is transmitted through the central nervous system. Thus, such a headache must follow a distribution that is central and not peripheral. Secondly, it is frequently accompanied by areas of superficial tenderness, such as I have described in chap. i.

Now, a careful examination of any patient suffering from true megrim, at once shows us that the character and distribution of the pain in this disorder bears no relation to that of referred pain. The tenderness in megrim has neither the character nor the distribution of that which accompanies referred pain. I can best illustrate this by the description of a case where I repeatedly had the opportunity of examining the patient during typical attacks of megrim.

Case 55.—Dr. G. W., aged 26.

March 1. At 10.30 a.m. the headache began with an intense boring pain around the left eye and over the forehead. This pain slowly shifted until it occupied a position four and a-half

[1] I have not yet seen a true case of megrim amongst hospital patients. All my patients were medical men.

EXPLANATION OF PLATES I. AND II.

On these plates an attempt has been made to represent the approximate limit of the areas on the head and neck which form the subject of this paper.

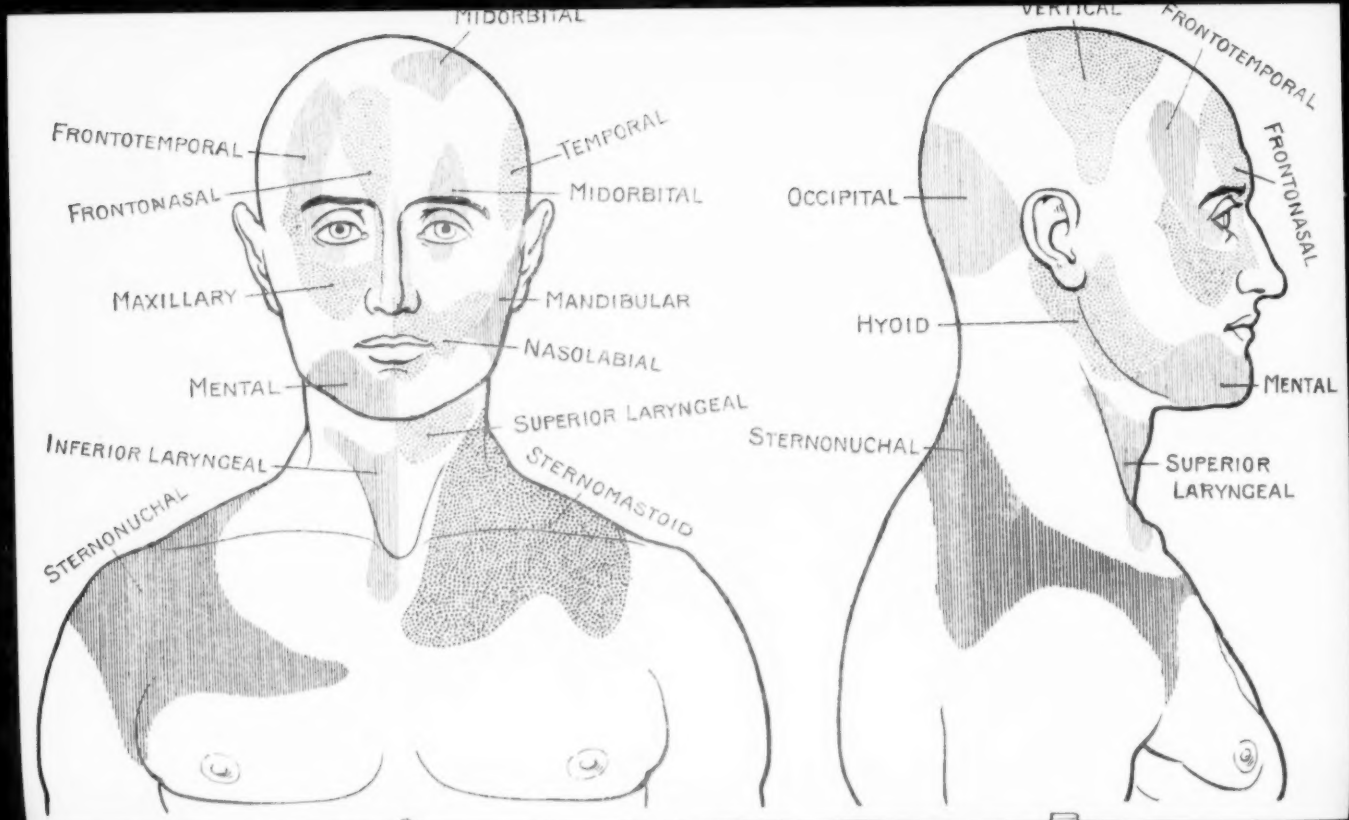
It will be noticed that the areas on Plates I. and II. are filled in with three colours—blue, red, and black. The group coloured blue consists of the occipital, parietal, vertical, temporal, fronto-temporal, mid-orbital, fronto-nasal, and the doubtful rostral areas. It is this group which is associated with areas of tenderness on the chest and abdomen (chap. iii.).

The areas coloured red become tender in affections of the organs of the head and neck, but, unlike the blue group, are not correlated with areas of tenderness on the thorax and abdomen.

The two black areas are the sterno-mastoid (third cervical segment) and sterno-nuchal (fourth cervical segment). They do not belong to the areas of the head, but are in reality the highest areas of the trunk. Thus they are not primarily affected in disturbances of any organs of the head and neck, and are not directly correlated, like the blue areas, with areas on the thorax and abdomen. On the contrary, they behave like areas on the thorax, and are associated with certain dorsal areas of the scalp (p. 457).

On Plates I. and II. I have given the full areas only; but, as I have repeatedly pointed out, a knowledge of the so-called "maxima" is of much greater practical importance than that of the complete areas. For clinical purposes the presence of a single maximum point shows that the area to which it belongs is affected, and the implication of the whole area does not materially add to the possibilities of diagnosis. If the full area to which the maximum point belonged were unknown, the diagnostic value of the maximum points would be much diminished. But knowing the area to which any maximum belongs, the presence of this maximum only is required for diagnosis. I have, therefore, given fig. 61 to shew the maximum points of those areas shewn in full on Plates I. and II.

My best thanks are due to Mr. W. J. Griffiths for the energy and ability expended over the drawings and plates in this paper.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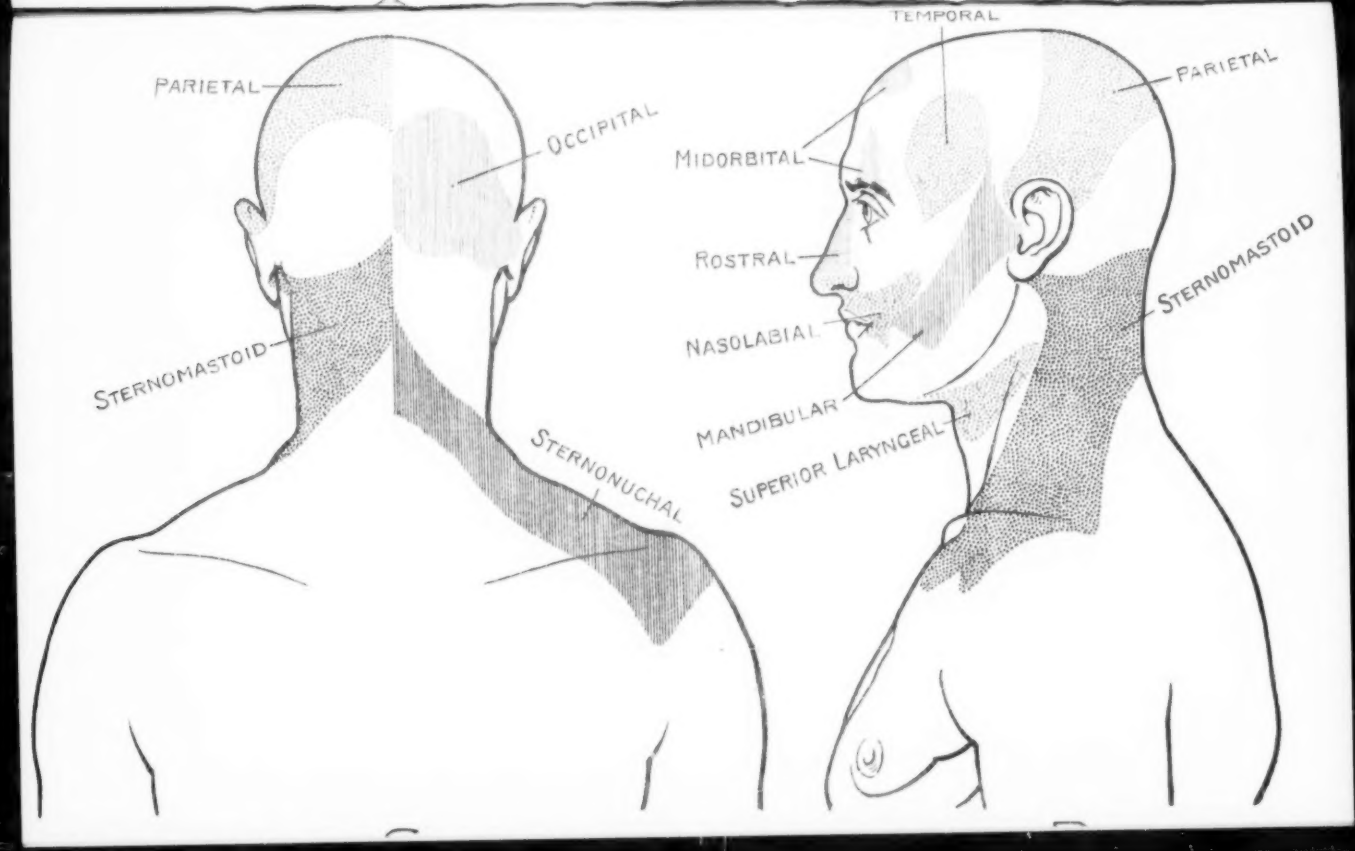
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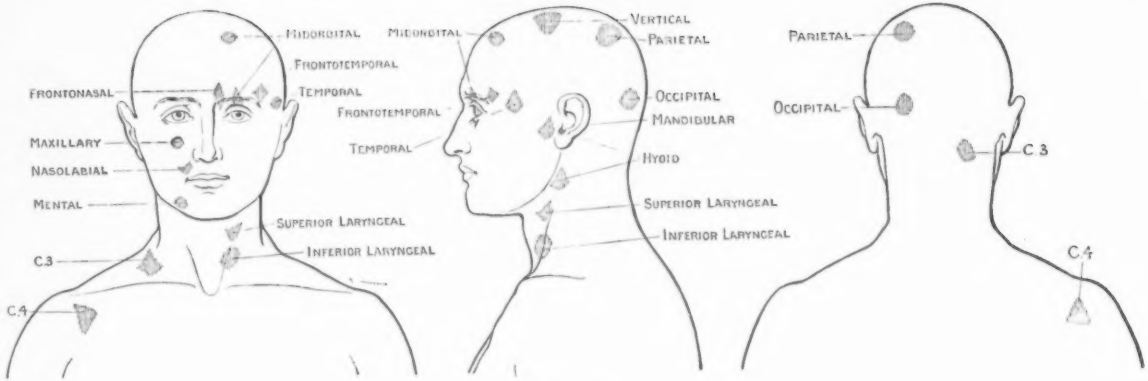

FIG. 61.

TO SHOW THE MAXIMUM POINTS OF THE AREAS DRAWN IN FULL ON PLATES I. & II.

inches above the zygoma and one inch from the middle line of the scalp. This patch was about an inch to an inch and a-half in diameter, and lay just in front of a vertical line from ear to ear on the left side of the head. After the headache had shifted to this position he still had an intense boring pain in the left eye. This attack was not preceded by visual phenomena, which only rarely occur in his attacks. The headache continued till 4.30 p.m., when he vomited. After this he slept, and woke in the evening free from pain and discomfort.

During the attack he was kind enough to allow me to examine his sensation thoroughly. He did not flinch when the hair was gently pulled or the skin picked up either over the area of pain or over any other area of the scalp. The blunt head of a pin felt blunt to him everywhere. There was no hyperæsthesia to heat or cold.

On the other hand, even the gentlest percussion was intensely painful over the area within which he complained of pain. In this way an area of deep tenderness could be percussed out having the limits I mentioned above.

His attitude was very characteristic. He half reclined in a long armchair with his head fixed by the cushion and his arm and his body jambed between the arms of the chair, so that all shaking and movement was impossible. If I held his head between my hands and shook it gently, it caused him agony. Rising from the chair caused him great pain, and going upstairs was an impossibility. Thus he did not resent any manipulations that did not press upon the tender place or shake the skull in any way.

He has very slight hypermetropia (+ 0·75.D.) which has been corrected without the least effect upon the frequency or severity of his attacks.

He is always constipated before the attack. His urine is normal.

Pulse not altered in rate or tension.

Now compare with this an attack of "sick headache," in which referred pain is the main factor. The patient has pain over the temples, and sits or lies with his head tightly clasped between his hands. In some cases he ties a bandage around his head, or applies a cold compress to the tender spot to ease the pain. Shaking his head does not appreciably increase the headache. He can rise and go upstairs. But he resents the least pulling of the hair or picking up of the skin over the painful spot. Thus he is found to have an area of superficial instead of deep tenderness, and this area will be found to correspond to one or more of the areas I have described in chap. i.

Sufferers from true megrim are of such a high order of intelligence that their own observations are very valuable. I will now give the observations made for me by Dr. F. on himself. The attack began on getting up at 9 a.m. on October 17. The vision became double, and then a central scotoma developed, which grew bigger and bigger. The diminution in vision became so great that he could not recognise people who entered the room. Twenty minutes after this the headache began as an intense boring pain over the inner part of the right eyebrow. It radiated over the right side of the forehead, and occasionally passed over a little to the left of the middle line. Whenever he moved there was an intense pain over the vertex to the right of the middle line. At no time was there any superficial tenderness of the scalp. He could not move his head, laugh, speak, or go upstairs on account of the pain these actions produced. About half an hour after the headache had begun, vomiting came on, associated with nausea. It was excruciatingly painful. This lasted till the afternoon, when he slept.

Those who suffer from true megrim are certain that they suffer from no superficial tenderness of the scalp during their attacks. The late Dr. James Anderson was kind enough to interest himself in this investigation, and repeatedly made observations, for my benefit, on the megrim attacks to which he was a martyr. He assured me that after repeated trials he was unable to find any superficial tenderness in himself during the attacks. The least percussion, however, caused him intense pain. He was hypermetropic, and had been corrected by one of our best eye surgeons without in the least diminishing the frequency or severity of his attacks.

Thus, in conclusion, I think we may say that true megrim is an affection *sui generis*, and not in any way related to referred pain.

The differences between true megrim and a referred headache may be tabulated as follows.

Megrim.	Referred Headache.
1. The pain follows areas differing fundamentally in distribution from those of referred pain.	1. The distribution of the pain follows the lines laid down in chap. i.

2. The pain is associated with intense deep tenderness.

3. Movement of the head, or anything that produces it (laughing, going upstairs, &c.) causes an increase of the pain.

4. The headache may be preceded by visual phenomena of the highest order, such as "fortification figures" scotoma, &c.

2. The pain is accompanied by more or less intense superficial tenderness.

3. Pressure relieves the pain, and the patient can go upstairs without producing much increase in the headache.

4. The headache is never preceded by these highly developed visual phenomena, but may be accompanied by amblyopia or coloured flashes of light.

CHAPTER V.

Do these Areas correspond to the supply of Peripheral Nerves?

The course of a nerve may be mapped out in three ways :—

(1) Anatomically—The nerve may be traced to its furthest point by dissection.

(2) The nerve may be divided and the anæsthetic area, so produced, mapped out. This method shows solely what part of the skin is supplied by this nerve alone. For should any portion of the skin be supplied by two nerves, division of one nerve will not render that part of the skin anæsthetic.

(3) The method adopted by Sherrington, which may be called the method of remaining æsthesia. He divides all

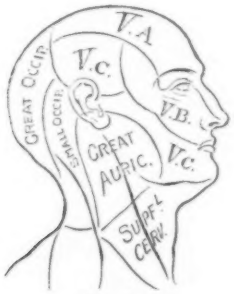

FIG. 54.

To show the distribution of the main branches of the fifth nerve and cervical plexus, determined by dissection. (For this figure I am indebted to Professor Thane.)

the roots above and below one single root, and thus leaves a sentient field in the centre of a desert of anæsthesia.

Let us see how far these methods enable us to trace the supply of the main nerve trunks of the head and neck.

The anatomist describes the supply of the branches of the fifth nerve somewhat as is represented on fig. 54. The ophthalmic division supplies the greater part of the nose and conjunctiva, the upper lid, and passes up to supply the hairy scalp as far back as the parietal eminence. The second division of the fifth nerve supplies the upper lip and cheek, whilst the third division supplies skin over the chin, part of the lower jaw, the greater part of the ear, and a portion of the hairy scalp over the temporal fossa.

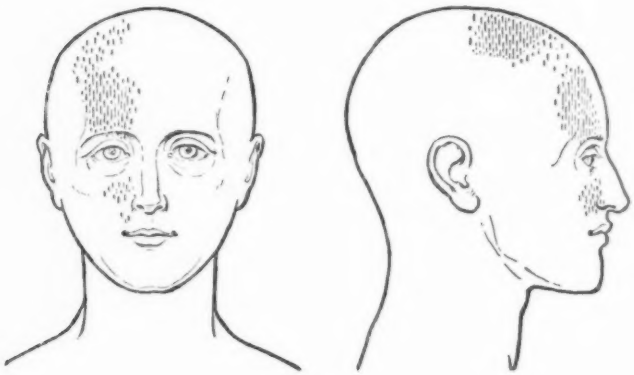

FIG. 55.

To show the loss to pain, heat and cold produced by excision of all the cutaneous branches of the ophthalmic division, and the whole of infra-orbital second division) of the fifth nerve on the right side. The loss to touch was still less marked than the loss to other forms of stimulation.

A line drawn along the posterior border of the black area on this figure, will represent the anterior border of the area supplied by the third division of the fifth nerve (by Sherrington's method of "remaining anæsthesia.")

When the supra-orbital, supra-trochlear, and infra-orbital portions of the fifth nerve are destroyed before they reach the face the resulting anæsthesia is much less extensive than we should expect from the anatomist's description of the supply of these nerves. Fig. 55 shows

the extent of the analgesia or loss to pain caused by division of these nerves for the relief of facial neuralgia. The loss to heat and cold closely followed the distribution of the loss to painful stimuli, but the loss to touch was less extensive.

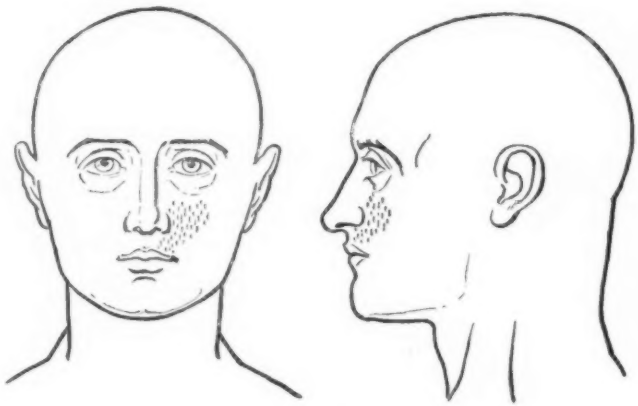

FIG. 56.

To show the loss to pain, heat and cold, produced by excision of the whole of the infra-orbital (second division) of the fifth nerve. There was no absolute anæsthesia to touch, but only a diminution in sensibility over a small area on the left cheek.

In another case Mr. Horsley divided the infra-orbital division only by following it back to the posterior wall of the antrum (fig. 56). The loss to pain stimuli consisted of an exceedingly small patch over which sensation was diminished, and there was practically no anæsthesia to touch.

I give a third figure (fig. 57) to show the result produced by dividing the third division of the fifth nerve at the foramen ovale (Salzer's operation). Here the resulting analgesia or loss to pain stimuli corresponds more nearly to the anatomist's description of the supply of this nerve. There was no absolute loss to touch anywhere (excepting within the area of the operation scar). But a touch was said to feel "wooden." Heat and cold followed the distribution of the analgesia.

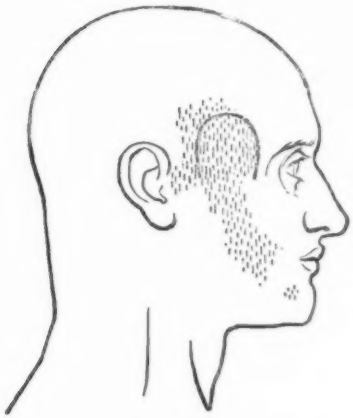

FIG. 57.

To show the loss to pain, heat and cold, produced by excision of the whole of the third division of the fifth nerve (Salzer's operation).

The curved black line represents the skin incision. Within this area the loss is more profound owing to the division of anastomosing nerves.

Thus, in all cases where one or more branches of the nerve are divided the loss to pain stimuli falls far short of the anatomical supply of the nerve, and the loss to touch stimuli is ridiculously small considering the gravity of the lesion.

If, however, all three branches are cut (fig. 58), a change takes place, and both the analgesia and anæsthesia are of considerably greater extent than when any two branches only are divided (compare fig. 58 and fig. 55).

Thus, both the anatomical and the destructive methods have grave disadvantages. The former cannot tell us the limits of the functional activity of the nerve; the latter only gives us the minimal area supplied by any branch.

The only satisfactory method of mapping out the supply of these branches is that adopted by Sherrington. He has been kind enough to allow me to include figs. 59 and 60 obtained by him from observations on monkeys, which are as yet unpublished. In order to map out the distribution of the ophthalmic division of the fifth he cuts the posterior roots

of the fourth, third and second cervical nerves, together with the second and third divisions of the fifth on one side. Eight hours or more afterwards he finds he can obtain a reflex by pinching the skin over the area in fig. 59. Thus, this area corresponds to the whole area supplied by the ophthalmic division of the fifth, for all the nerves below have been

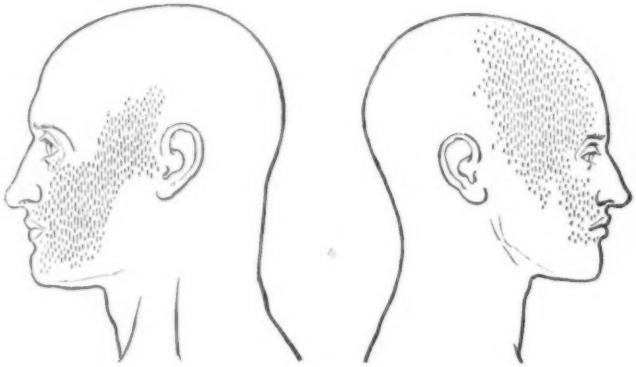

FIG. 58.

The *left hand* figure shows the loss to pain, heat and cold, produced by dividing the second and third divisions of the fifth nerve.

A line drawn along the upper border of the shaded patch represents the lower border of the supply of the ophthalmic division of the fifth nerve by the method of "remaining æsthesia" (Sherrington). Compare Sherrington's observation on the monkey (fig. 59).

The *right hand* figure represents the loss to pain, heat and cold, produced by destruction of all the cutaneous branches of the fifth nerve.

A line drawn along the posterior border of the shaded patch represents the anterior border of the supply of the posterior root of the second cervical nerve by the method of "remaining æsthesia." Compare Sherrington's observations on the supply of this root in the monkey (fig. 60).

divided. In the same way he traces the posterior border of the fifth nerve by dividing all the upper cervical posterior roots. A glance at fig. 59 shows how the area of sensation which remains oversteps the limits described by the anatomist, or those of the analgesia produced by dividing the nerve itself.

Fig. 59 and fig. 60, which I owe to Dr. Sherrington's kindness, also show the upper and lower limits of the second, third and fourth cervical roots observed by his method.

Clinically we possess the means of mapping out the distribution of at any rate some of the branches of the fifth nerve by practically the same method as that adopted by Sherrington. For after dividing the middle and lower

FIG. 59.

FIG. 60.

To show the areas supplied by the ophthalmic division of the fifth, by the whole fifth nerve, by the second, third and fourth cervical nerves in the monkey, determined by Sherrington's method.

Compare the right hand drawing of fig. 59 with the left hand drawing of fig. 58, and the anterior border of the second cervical on fig. 60, with the posterior border of the anæsthetic area on the right hand drawing of fig. 58.

divisions of the fifth nerve for facial neuralgia, a sentient area is left which represents the supply of the uninjured ophthalmic division of this nerve. A comparison of fig. 58 (left figure) with fig. 59 (right figure) shows how closely this area in man resembles that found by Sherrington in

the monkey. In the same way the area which remains sensitive after division of all three branches of the fifth nerve (fig. 58) represents the anterior border of the posterior root of the second cervical.

Now a comparison of the areas in chapter i. with the areas of distribution of the cervical nerves and of the branches of the fifth shows a difference and at the same time a likeness. Thus, Sherrington's fourth cervical bears a resemblance to my sterno-nuchal area, and his third resembles my sterno-mastoid area.

But although there is a likeness the differences are profound. The overlap in the supply of these peripheral branches is enormous. Thus, the anterior border of the supply of the posterior root of the third cervical touches the posterior border of the third division of the trigeminal.

Thus, the whole large area of the second cervical is superposed on skin already supplied by the trigeminal in front and the third cervical behind.

Thus, I think we are forced to conclude that my areas of tenderness represent some more central nervous arrangement than the posterior roots of the cervical plexus and main branches of the fifth nerve.

CHAPTER VI.

Theoretical.

We have now seen that, although the boundaries and form of the tender areas are foreshadowed in the distribution of the peripheral branches of the nerves of the head, these areas represent neither the posterior roots of the cervical nerves, nor the three branches of the trigeminal. In Part i. of this work I came to a similar conclusion with regard to the significance of the tender areas on the body. I then tried to show that although they did not represent the supply of posterior roots, they corresponded to the distribution of segments of the spinal cord. One might then suppose that the analogous areas on the head and neck

also represented cephalic segments. But so much shifting has taken place in the head that we cannot say whether each area on the head is be considered the equivalent of a whole zone from dorsum to venter on the body or only to a portion of such a zone. Thus we are unable to say whether the temporal area on the scalp represents the supply of a segment in the cephalic nervous system equivalent to the seventh dorsal area on the body; or whether the temporal maxillary and naso-labial must be combined to produce the homologue of a complete sensory band on the body.

There are, however, certain points in which these areas on the face and scalp seem to retain the marks of the changes which occurred in the development of the face and head in the human embryo.

The face is developed by the union of three tissue masses. The mesial nasal process descends from above, and finally becomes the bridge of the nose (on the surface).[1] On each side of this mesial portion the lateral nasal process descends between the mesial process and the eye to form the ala and side of the nose. It also possibly enters into the formation of the mesial structures of the upper jaw. The maxillary processes come inwards on each side to meet in the middle line, and form the upper lip.[2]

Now, the nasal portion of the fronto-nasal sensory area bears upon it the traces of some such downward growth, whilst the maxillary area shows similar traces of a growth inwards from the sides of the face.

The tongue is developed in two portions. The front of the tongue is formed from a tuberculum impar in connection with the ventral portion of the mandibular arch. The posterior and postero-lateral portions are formed from a mass produced by the coalescence of the ventral portions of the hyoid and of the third postoral arches. Thus the mandibular hyoid and third postoral arches all take part in the formation of the tongue.

[1] His, "Anatomie Menschlicher Embryonen," Leipzig, 1885 (a large number of His's figures are reproduced in "Quain's Anatomy," tenth edition, vol i., part i.).

[2] *Cf.* Hochstetter, *Verhandlung d. Anatomischer Gesellschaft*, 1891, p. 145, and 1892, p. 181.

Now, the sensory supply of the tongue stands in relation with the same nerve elements that supply three separate areas on the face. The anterior part of the tongue stands in relation with the mental area on the face. This area lies over the front of the lower jaw and is connected with the incisors, canine and first bicuspid on each side. The lateral part of the tongue is in connection with the hyoid area—an area which is closely connected with the tonsil and membrana tympani. The posterior part of the tongue stands in relation with the superior laryngeal area of the neck; and this area is in close connection with the upper part of the larynx. Thus an area associated with structures developed from the mandibular arch supplies the front of the tongue; an area connected with structures developed from the hyoid arch supplies the sides of the tongue; and an area in connection with structures developed from the third postoral arch stands in relation with the back of the tongue.

The next area below, the inferior laryngeal, supplies the larynx proper, which is developed from the fourth postoral arch. It is interesting to notice that the sensory nerve through which this reference from the larynx to the inferior laryngeal zone on the skin must take place, is the recurrent laryngeal. This nerve curls round the arch of the aorta, which we know to be the representative of the vessel of the fourth postoral arch.

The tragus is developed from the mandibular arch, the lobule and antitragus from the hyoid arch.

Now, what I have called the mandibular sensory area supplies the tragus, whilst the lobule and antitragus are supplied by the hyoid sensory area.

During the development of the neck the somatic structures from behind come forwards to enclose the branchial structures in front, which belong to the head. His states that the anterior border of the sterno-mastoid muscle fairly represents the point at which the somatic structures meet the structures of the anterior part of the neck (of branchial origin).

Now the same line fairly represents the anterior border of my third cervical area, and we saw reason to believe

(p. 457) that the third and fourth cervical areas of the neck behaved like areas of the body, and not like areas of the head and neck. For they are associated with frontal tenderness on the scalp, and thus behave differently from any other areas of the neck or face.

Thus these tender areas of the face and neck seem to retain the marks of the developmental processes which have led to the formation of the human head. Further than this I do not think we can justifiably go at present.

In chapter iii. I attempted to show that organs of the thorax and abdomen not only refer on to areas of the body, but on to areas of the head.

Now these areas on the body represent the supply of segments of the spinal cord. Thus we are tempted to conclude that the areas on the scalp which stand in correlation with them represent a similar segmentation of the cephalic nervous system.

These areas which stand in relation to the areas of the body lie above the following line.—It starts from the side of the nose, runs upwards, and along the lower border of the bony orbit. Thence it runs with a sloping course upwards to a point above the ear. It then dips sharply downwards to end below the occipital protuberance.

There seems to be a fundamental difference between the areas which lie on the dorsal side of this line to those which lie below it. I cannot help thinking that if there are any traces of segmentation in the cephalic nervous system akin to that in the spinal cord, we must seek for it amongst these dorsal areas of the scalp and not amongst those of the face or neck.

Why should disturbances of the thoracic and abdominal viscera cause pain and tenderness within the distribution of the trigeminal?

On examining the supply of the dorsal areas of the scalp from peripheral nerves we find that they receive branches partly from the fifth nerve, and partly from the posterior

roots of the second, and possibly third, cervical nerves. The great bulbar nucleus (so-called ascending nucleus) of the trigeminal descends as low as the second cervical, and is probably a continuation above of the nuclei of the posterior roots of the cervical nerves.

Thus, if we take the sensory nucleus of the trigeminal and add to it the nucleus of the posterior root of the second cervical, the sum total must consist of at least eight primitive nuclei akin to the nuclei of posterior roots. Of these one belongs to the second cervical, one to the first cervical, which no longer has connection with a single peripheral root, but is partly in fifth and partly in the second cervical nerve bundles. The remaining six nuclei, corresponding to the rostral, fronto-nasal, mid-orbital, fronto-temporal, temporal and vertical areas, belong to the head.

Originally each of these hypothetical nuclei received a direct ramus which passed into it at its own level. But for some reason we do not understand, these rami disappeared and the fibres now reach their nuclei by an indirect route, through the great trunk of the fifth nerve. Hence the enormous downward prolongation of the bulbar (so-called ascending) root of the fifth.

All the thoracic and abdominal viscera which refer into the dorsal areas of the scalp, are supplied by the nerve which must be called the vago-glosso-pharyngeal. Now Gaskell has pointed out that the vagus and glosso-pharyngeal represent the visceral branches of a set of nerves, whose somatic sensory roots are to be found in the sensory portion of the fifth. If this is true it is not surprising that the impulses passing up the vagus should be referred to the area of the fifth. Why, however, they should stand in relation to the areas supplied by segments of the spinal cord remains inexplicable.

Speculation on such points is easy but liable to be unprofitable, and I must crave my readers' indulgence for the extent to which I have entered into possibly fanciful theories in this chapter.

It is now my pleasant duty to thank those who have helped me in various ways during this investigation.

My thanks are due to the medical and surgical staff of University College Hospital for the kind way they have permitted me to use their cases.

To the staff of the City of London Hospital for Diseases of the Chest (Victoria Park) I return my thanks for the exceedingly liberal way in which they have allowed me to make use of the cases that came under my charge when house physician. To the Lay Committee of this Hospital I also return thanks for extending my period of office beyond the usual term.

I beg also to thank the medical and surgical staff of the National Hospital for the Paralysed and Epileptic (Queen Square), for permission to use my observations on their cases.

My especial thanks are due to the staff of the National Dental Hospital, for the exceedingly liberal way they have permitted me to use their cases without let or hindrance.

I beg to offer my especial thanks to the following gentlemen:—To Mr. Horsley, for permission to study his cases of trigeminal neuralgia. To my late chief, Dr. Buzzard, for his liberality and kindness to me. To Mr. Sidney Spokes, for much sympathy and help in the dental section. To Mr. Tweedy and Mr. Marcus Gunn for their kindness during the time I acted as their assistant. To my friend, Dr. Sherrington, for much help and for permission to embody the results of some of his unpublished work, in this paper. And, lastly, to my colleagues, the residents at the Victoria Park Chest Hospital, my thanks are due for much kind thought and valuable aid in diagnosis.

LOCAL ANÆSTHESIA AS A GUIDE IN THE DIAGNOSIS OF LESIONS OF THE UPPER PORTION OF THE SPINAL CORD.

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THE importance of the careful analysis of special symptoms and of their relation to localised lesions in the nervous system can hardly be exaggerated. There is perhaps no better proof of this statement to be cited than the exact results which have been reached by the study of paralysis and anæsthesia following transverse lesions in the spinal cord. It has been possible to determine the various levels or segments of the cord which are in functional relation with certain muscles and regions of the skin. This has been most exactly worked out for the lower half of the body and its relation to the lower portion of the spinal cord by the independent researches of Thorburn[1] and myself,[2] and recently by Head.[3]

[1] The "Surgery of the Spinal Cord," 1889; also BRAIN, 1893, p. 373.

Thorburn's criticism that my diagram shows no skin areas connected with the fourth lumbar and second sacral nerves is not quite just, as the following quotation from my article shows:—

"The *fourth zone* is of a similar shape to the third, but more extensive, a greater surface on the back of the thighs being involved, and the anæsthesia extends in a band almost as low as the popliteal space. This area has been established clinically in several cases; there is as yet no autopsy to determine its lesion; but since the smaller zone is due to lesion at the third sacral segment, and the next larger zone is due to lesion in the fifth lumbar segment, it is allowable to conclude that this region corresponds with the second and first sacral segments. In thus outlining four zones of the skin and assigning them to various segments of the sacral portion of the spinal cord, it is not my intention to lay down artificial boundaries or to affirm that all cases will exactly coincide. I only wish to show that as the cord is invaded by disease from below upward, the area of the skin which becomes anæsthetic increases in extent, and that the shape of the area is characteristic; so that from the study of the area the extent of the lesion can be determined. The *sixth zone*

As a further contribution to this subject I propose in the present article to consider the anæsthesia produced by lesions of the cervical segments of the cord. This will be less difficult since cases are not wanting both in the recent literature and in my own experience to aid in this study.

A few remarks regarding the anatomy of the cervical segments of the cord and the relation of these segments to the cervical vertebræ may not be out of place. It is to be remembered that there is no natural boundary between adjacent segments of the human cord. The nerve roots issue from the cervical cord in a continuous series, and it is only by following out individual nerve roots to the various points of exit, through the dura mater, that it is possible to trace any one particular root into the cervical nerve to which it belongs. If, on the other hand, any nerve be traced into the cord, it will be found to sub-divide, some portions passing directly into the gray matter, others turning downward and others ascending in the cord, so that any one root really reaches several levels of the cord.

It cannot therefore be affirmed that individual segments of the cord are in any special or direct relation with single cervical nerves, and therefore the symptomatology of spinal cord lesions in the cervical region at different levels will be different from the symptomatology of lesions of the individual cervical nerves, or even of lesions of the nerve roots.

of anæsthesia is produced by a lesion of the third lumbar segment. When the third lumbar segment is diseased, the entire back of the thighs and legs is anæsthetic, and the front of thighs is also anæsthetic, except over a funnel-shaped zone which extends from above downward, the narrow tube of the funnel reaching along the shin even to the foot. This zone will probably be separated later into two separate parts corresponding to lesions of the fourth and third lumbar segments. There is not as yet a sufficient number of cases to warrant such a distinction. The exact limits of anæsthesia on the feet are still uncertain, and no more exact statement than that given is warranted."

It seemed to me better to abide closely by actual facts than to assert conclusions without the pathological basis of exact spinal lesions. I do not think any definite conclusions can be deduced from cases of pressure on the cauda equina. While I think it quite probable that Head and Thorburn are correct in assigning the sole and outer side of the foot to the first sacral segment, I know of no case of *spinal cord lesion* with autopsy to establish this fact.

[2] *American Journal of Medical Sciences*, 1892, and *American Journal of Neurology*, 1884.

[3] BRAIN, 1893, p. 44.

In discussing lesions of the cervical enlargement of the cord, authors have usually been contented to describe the symptoms produced by destruction of the lower, middle and upper thirds of the enlargement, and this is perhaps sufficiently accurate for all purposes of diagnosis. Nevertheless, after the study of the cases here collected I shall attempt to assign to each segment its special function, although it is admitted at the outset, that scientific precision rather than practical use will be the chief result.

The relation of the cervical segments of the cord to the spines and bodies of the vertebræ is by no means a constant one. It will be remembered that Gowers in 1884 published a diagram to demonstrate these relations which has been accepted ever since that time. Gowers says:[1] "The first three cervical spines are opposite the origin of the third, fourth and fifth cervical nerves. The sixth and seventh pairs arise opposite the intervals between the fourth and fifth, and the fifth and sixth, cervical spines respectively. The sixth cervical spine corresponds to the origin of the eighth cervical nerve, and the seventh cervical spine to the first dorsal nerve. Thus the cervical enlargement of the cord which ends at the origin of the first dorsal nerve corresponds nearly to the bodies and spines of the cervical vertebra."

While this summary is undoubtedly very nearly correct it must be admitted that it does not hold for all cases. In 1891, Kraus called attention[2] to the fact that fractures of the sixth and seventh cervical vertebræ crushing the cord often produce very different symptoms in different individuals, the extent of the paralysis being by no means uniform, although the site of the fracture is the same. This fact was confirmed in 1892 by the series of cases published by Church and Eisendrath.[3] The facts presented by these authors can only be explained upon the supposition that in different individuals the relation of the segments to the vertebræ differs.

Quain in the last edition of his "Anatomy" admits this fact. Quain states that the lower limit of the cervical enlargement

[1] "Diseases of the Spinal Cord," 1884, p. 6.
[2] *Zeitschrift für Klin. Med.*, xviii.
[3] *Amer. Jour. Med. Sciences*, April, 1892.

lies opposite the body of the first or second thoracic vertebra. But inasmuch as the thickness of this body is at least an inch, it is evident that this implies a decided variation in the relation of individual segments of the cord to the vertebræ. This variation is also brought out by a diagram of Reid[1] shown in fig. 1. The position of attachment of the nerve roots to the spinal cord in six adult subjects and the relation of these to the spines of the vertebræ are shown in the diagram. It is evident from its study that no exact conclusion can be drawn as to which segment of the cord is destroyed in a fracture of one vertebra. The possible

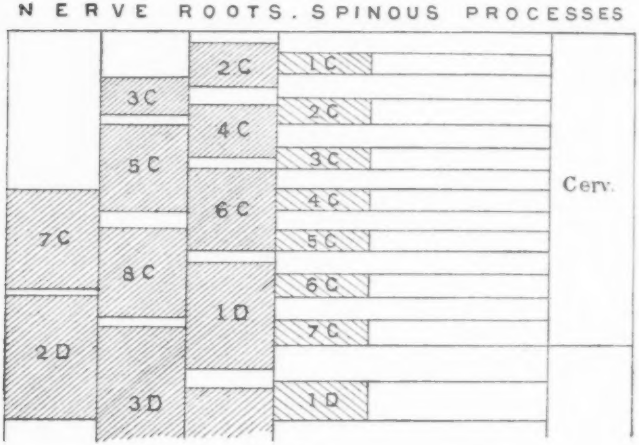


FIG. 1.

Chart showing the limits of the variations in the topographical relation between the superficial origins of the nerve roots from the spinal cord and the spinous processes of the vertebræ.—Reid.[2]

result, for example, of a fracture of the seventh cervical vertebra would be a destruction of either the eighth cervical segment or the third dorsal segment or segments between these in different cases. It is evident, therefore, that while Gowers' statement may be taken as representing the average

[1] *Jour. of Anat. and Phys.*, xxiii., 1889.

[2] *Jour. of Anat. and Phys.*, 1889, vol. xxiii., p. 341.

condition, there are considerable variations in the relation between the cord and the spine.

There is another fact which must be stated as a necessary preliminary to the study of anæsthesia due to spinal lesions, the fact which has recently been brought out by the investigations of Sherrington.[1]

Sherrington found, in an attempt to determine the area of the body functionally related to the various posterior nerve roots in the monkey, that division of one root alone was not attended by any anæsthesia, and that to determine the area of skin supplied by a single dorsal nerve it was necessary to divide at least three dorsal nerve roots.[2]

The conclusion to be drawn from Sherrington's researches, as shown in his diagram (fig. 2), is that every part

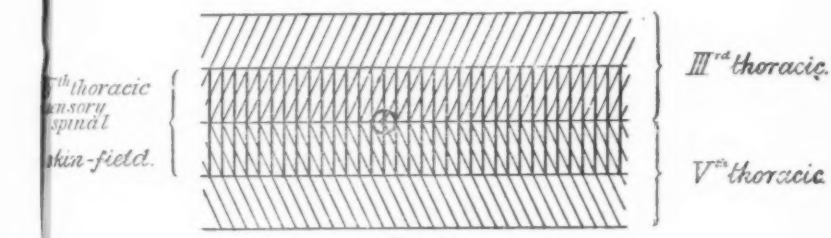


FIG. 2.

of the skin is supplied with sensation by three sensory nerve roots, whose peripheral branches overlap one another or anastomose. In order to deprive the area of skin of sensibility, all three nerve roots must be cut. This fact gives the rational explanation to the correlated fact which has been observed by clinical investigators, and to which attention was called especially by Horsley and Gowers in 1889;[3] namely, that in a transverse lesion of the spinal cord, the

[1] "Experiments in examination of the Peripheral Distribution of the Fibres of the Posterior Roots of some Spinal Nerves."—*Philosoph. Transactions of the Royal Society of London*, vol. clxxxv., B. p. 641. Charles S. Sherrington.

[2] I have confirmed this observation in man; for in a case of spinal injury recently operated upon by Dr. McCosh for me, one pair of dorsal nerves was divided, but no anæsthesia was produced.

[3] *Medico-Chirurgical Transactions*, vol. lxxii., p. 21: "Report of a Case of Tumour of the Spinal Cord."

band of anæsthesia about the body was uniformly at a level from two to four inches lower than the level of the lesion in the cord. If, for example, as in my first case, the level of anæsthesia is about the body at the level of the nipples, that is, corresponding to the fifth dorsal nerve, the lesion in the cord cannot be lower than the fourth dorsal nerve or fourth dorsal segment. For were it at the fifth dorsal segment, the fourth dorsal nerve being still intact would supply with sensibility the skin in the fifth dorsal area. This fact is of practical importance in determining the position of a lesion in the cord, such as a tumour, and justifies the dictum of Horsley, that in removing tumours from the cord the tumour is to be sought from two to four inches above the level indicated by the line of anæsthesia. I can confirm this from my own observation in two cases of spinal cord tumours recently successfully removed, and which will be reported elsewhere.

This fact of collateral supply of skin by adjacent nerves will also explain the clinical fact that the distribution of anæsthesia upon the arms in lesions of the cervical cord is not always uniform.

With these preliminary observations, I will now proceed to relate a number of cases from my own experience and from reliable observers, which demonstrate the various symptoms produced by lesions at various levels of the upper dorsal and cervical segments.

Case I.—Transverse lesion at the fourth dorsal segment of the cord. Unusual symptoms. Remarks.

H. D., aged 46, had always been in good health until his present illness, though he had a chancre with slight secondary symptoms of syphilis in 1882. On December 4, 1884, without any apparent cause he began to suffer from pain in his back, and the next day he became suddenly paralysed in legs and body, lost sensation below his navel and lost control of his bladder and rectum. The condition of total paraplegia had remained up to the time I first saw him, in consultation with Dr. L. A. Sayre on October 24, 1888; and remains at present (1894). His condition on October 24, 1888, was as follows:—

He lay upon a smooth, hard bed, totally naked, and apparently in considerable pain, and was turned every ten minutes from one side to the other by his attendants, by being lifted on a sheet, as this was the least painful method. The pain caused by the dorsal position was too great to be endured. His pain was referred to the spine at the fifth dorsal vertebra. There was no deformity there, but he was extremely tender to touch, and to a hot sponge over an area three inches wide the centre of which was at the fifth dorsal spine. He was accurate in all his statements.

Sensation.—There was a condition of absolute anæsthesia to touch, temperature, pain, and muscular sense, below the level of a line extending round the body at the level of the fifth dorsal spine. This line did not follow the course of the fifth intercostal space but in front was just opposite to the level behind, being

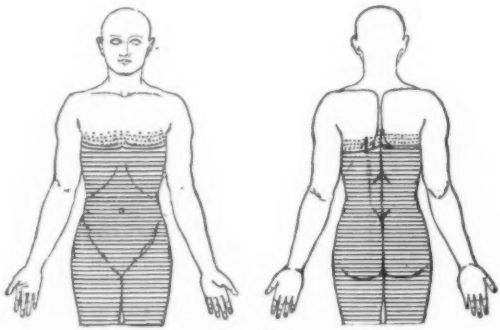


FIG. 3.

Case I.—Starr. Anæsthesia in lesion at fourth dorsal segment.

about an inch below the nipples. It was not an absolutely straight line, however, appearing to dip down a little behind on the left side. (Fig. 3.) Above this anæsthetic line there was a zone of very intense hyperæsthesia of three inches in width, its upper limit fading off into that of normal sensation. The hyperæsthesia was so extreme that any touch was painful, and hence he would not allow even the bed clothes to cover his body, and he always lay naked in a very hot room. The sensation of all parts above the hyperæsthetic area was perfect. *Whenever he was touched at any spot in the anæsthetic area he felt pain in the back at the fifth dorsal vertebra.* This statement was repeatedly confirmed. A touch or prick on the foot or abdomen was felt in the back but not at the point touched.

Motion was absolutely lost in all muscles of back, body, and legs below the fifth dorsal vertebra. It was perfect in the arms. The muscles were somewhat atrophied uniformly, from disuse. They were all relaxed, not at all rigid or contractured, but were abnormally sensitive to percussion and contracted on any strong sensory stimulus like that of a sharp prick on the skin over them. Their reaction to electrical stimulus both faradic and galvanic was normal, and even in the seventh intercostal space reaction was good. His sensitiveness prevented electrical tests of the sixth and fifth and fourth intercostal muscles. His feet were dropped, but not held rigid by contracture.

Reflexes.—Epigastric reflex lost. Gluteal, cremasteric and plantar reflexes normal. Abdominal and patella reflexes increased, no ankle clonus. His bladder empties itself spontaneously as soon as about three ounces of urine have collected, but there is no dribbling. For two weeks after the onset there was retention and a catheter was used, but since then active incontinence has been present. His rectum has to be evacuated by digital manipulation.

Vasomotor Condition.—If he lies more than fifteen minutes on any spot it becomes red, and will within a few hours become blue and go on to a bedsore. He has had numerous bedsores, one deep one over the sacrum, which had been healed with difficulty, and scars remain. The application of heat—as by hot bottles—or of electricity, or the mere scratch of a finger nail is soon followed by a broad zone of redness. There is always more or less redness over the bony prominences. It is to avoid bedsores that he is turned every ten minutes day and night. The growth of hair and of the nails was in no way abnormal.

Remarks.—The diagnosis of spinal hæmorrhage or of hæmorrhagic myelitis seemed quite evident in this case, and its level at the fourth dorsal segment of the cord was indicated by the level of the anæsthesia.

There were certain facts which made the case an interesting one, viz. :

First, the limits of the anæsthesia. This did not follow the line of the fifth intercostal nerve and thus describe a curve convexity down around the side of the body, but was practically horizontal to the vertical axis. This confirms the observations of Church and Eisendrath (*American Jour-*

nal of Medical Sciences, April, 1892), in five cases, and also Head's statement.

Secondly, the patient, though anæsthetic below this line, felt any touch or pain in the anæsthetic region at a spot in

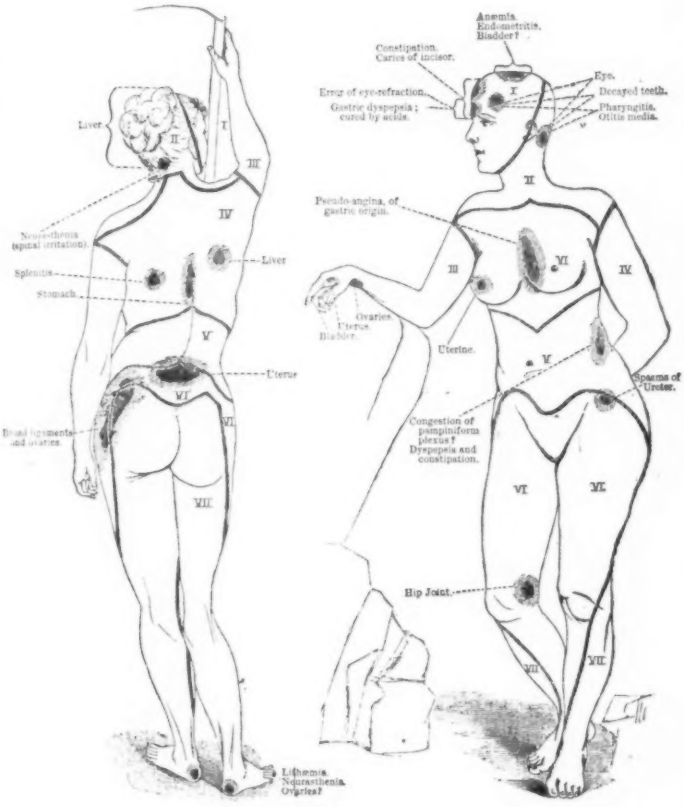


FIG. 4.

Dana. Situation of Referred Pains.

the back at the level of the lesion. I have observed this symptom in several cases of transverse myelitis, though I do not recall any special mention of it in the literature.

The impression sent inward from the skin evidently travels up the cord to the level of the lesion; there sets up an irritation which is then referred erroneously to the lowest area in which sensation can be felt, viz.: to the hyperæsthetic area just above the lesion. The explanation is the same given by Head in chapter vi. of his article, and long ago offered by Dana in his article on "A Clinical Study of Neuralgias and of the Origin of Reflex or Transferred Pains." *New York Medical Journal*, July 23 and 30, 1887.)[1] Such a referred sensation would not be possible in a case of total destruction of the cord, and hence like the loss of knee-jerk, may be of value in diagnosis.

Thirdly, the absence of rigidity and contraction in the legs after nearly four years of total paraplegia in spite of increased knee-jerks, is in my experience exceptional.

It is common to find a flaccid paralysis after total lesions of the cord which destroy the gray matter in its entire length, and thus remove the tonic influence of the spinal centres. It is also possible to have a flaccid paralysis in the muscles below a transverse lesion of the cord which entirely destroys a single segment, but under these circumstances the absence of knee-jerks (as first shown by Bastian) establishes the diagnosis of a destructive lesion.

In my case the knee-jerks were not lost, and the condition of sensibility just mentioned, proved that a total destruction of the cord, or a complete transverse lesion had not occurred. I cannot offer any explanation for the facts, but think they should be put on record.

Case II.—Fracture of the seventh cervical vertebra, crushing the first dorsal segment of the cord.

Bruns has recently[2] published a very careful record of a case of traumatic lesion of the spinal cord by a dislocation of the last cervical upon the first dorsal vertebra, destroying

[1] It must be remarked that many of Head's statements regarding the reference of visceral pain to surfaces of the body are to be found in this remarkable article of Dana which he has apparently overlooked, and the figure of which is here reproduced. (Fig. 4.)

[2] *Arch. für Psych.*, xxv., 759, 1893.

the first dorsal and lower part of the eighth cervical segments.

The symptoms observed were as follows: complete flaccid paralysis of the legs, with loss of knee and ankle reflexes and of all skin reflexes; paralysis of the body muscles, paralysis of the small muscles of the hands and of the long flexors of the fingers on both sides, with atrophy and reaction of degeneration. Complete anæsthesia up to the second rib and to the spines of the scapulæ; above this, on the body and on the upper extremities hyperæsthesia and pains, but no anæsthesia. (Fig. 5.) Com-

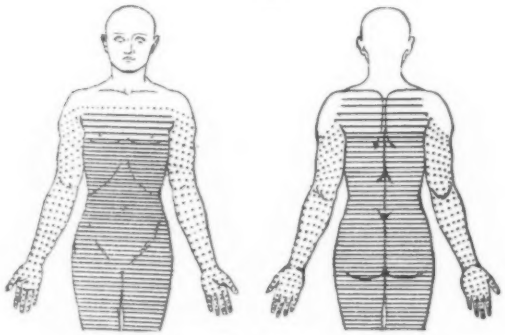


FIG. 5.

Case II.— Bruns. Anæsthesia in lesion of first dorsal.

plete paralysis of bladder and rectum, with retention. Purulent cystitis. Priapism. Contraction of pupils and narrowing of the palpebral fissures; bedsores; œdema of the legs, with trophic disturbances of the skin and joints. This condition changed slightly up to the time of the patient's death, which occurred 104 days after the injury; there being a partial return of sensation as low as the fifth rib on the body, a subsidence of the hyperæsthesia of the arms, a return of pupil and lid condition to normal, and an improvement in the motion of the fingers.

Remarks.—In view of the fact already established by Reid that the second dorsal segment may lie under the seventh cervical spine; and in view of the fact that recovery of sensation and motion in the arms and hands is inconsistent with a lesion of the eighth cervical segment, I am inclined to suppose that in examining this cord, Bruns has erroneously located the lesion, and that it lay one segment lower than he supposed. This is the only explanation which enables one to bring the facts into harmony with the very numerous cases observed by others.

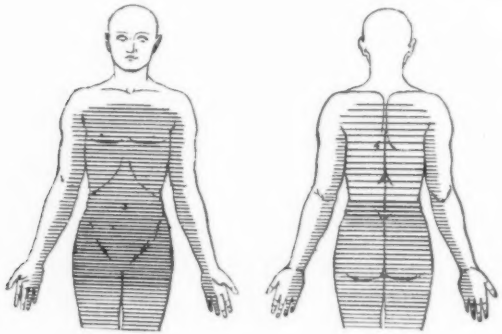


FIG. 6.

Case III.—Bruns. Anæsthesia in lesion of seventh cervical.

Case III.—Hæmorrhagic myelitis after injury to the lower cervical segments. Sensory and motor symptoms.

Bruns reports[1] another case of injury of the back followed by softening, with hæmorrhage in the lower half of the cervical enlargement. The softening involved the seventh and eighth cervical segments in their entire extent; the sixth segment was a little softened in its central region; the first dorsal segment was normal. The symptoms were total paraplegia with loss of knee-jerks, and paralysis of bladder and rectum. The paralysis involved the hands, there being total paralysis of the fingers, and of the long

[1] *Deut. Med. Woch.*, 1889, vol. xv., p. 984.

flexors of the wrist and weakness of the long extensors. Pronation and supination were good and elbow motions unimpaired. The anæsthesia was total up to the level of the umbilicus and partial from there to the level of the second rib. (Fig. 6.) All sensations were lost in the ulnar half of the upper extremities on both dorsal and palmar surfaces, while perfectly preserved on the radial half. The patient died a few days after the injury.

Case IV.—Fracture dislocation of seventh cervical vertebra, crushing the spinal cord at the eighth cervical segment. Motor and sensory symptoms.

Herter reports[1] a case quite similar to the last one which may be summarised as follows :—A fracture of the seventh

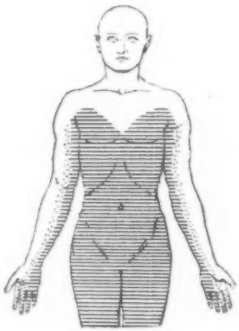


FIG. 7.

Case IV.—Herter. Anæsthesia in lesion of seventh cervical.

cervical vertebra with dislocation forward of the sixth. The cord was crushed at the eighth cervical segment and softened at the seventh segment, contained numerous hæmorrhagic foci which extended into the sixth segment being surrounded by inflammatory cells. The fifth segment was fairly healthy, though showing some inflammation. The paralysis in this case involved the legs and body, and the muscles of the

[1] *Jour. Nerv. and Ment. Dis.*, June, 1891.

hands and forearms, but those of the arms and the supinators and pronators were exempt at the outset. After a few days the pronators were paralysed, and the triceps and biceps became weak. In the paralysed muscles electric reactions were greatly diminished to both currents in five days. Reflexes absent except the cremasteric. The area of anæsthesia, is shown in the diagram. (Fig. 7.) It involved the inner side of both arms and hands, and along its outer limit there was a narrow line of hyperæsthesia.

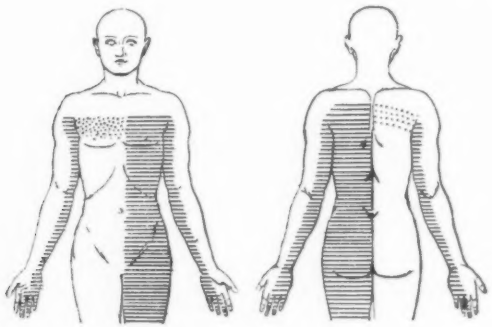


FIG. 8.

Case V.—Williamson. Anæsthesia in lesion of seventh cervical.

Case V.—Myelitis of the cervical region with unilateral sensory disturbances.[1]

A girl 13 years old was suddenly seized with paralysis of arms and legs and of the sphincters during the course of typhoid fever, from which she died within a month of the onset of the paralysis. The symptoms observed were paralysis of all four extremities with the exception of the muscles of the upper part of the arm, deltoid, biceps and spinators being exempt. The knee-jerk was lost upon left side. There was no anæsthesia to touch, but sensations of pain and temperature were entirely lost over the left side of the body up to the level of the third rib, and upon the inner sides of the arms as shown in diagram. (Fig. 8.) There was a small

[1] Williamson, *Lancet*, January 21, 1893.

region of hyperalgesia across the right side of the body and back.

The diagnosis was made of a hæmorrhage in the cord, and from the resemblance of the anæsthetic condition to that occurring in syringomyelitis, it was supposed that the gray matter only was affected.

Autopsy showed an acute myelitis without hæmorrhage in the first dorsal and eighth cervical segments of the cord, especially upon the right side.

Case VI.—Fracture dislocation of the sixth vertebra, crushing the eighth cervical segment. Motor and sensory symptoms.

The following interesting case has been carefully reported by Dr. C. A. Herter.[1]

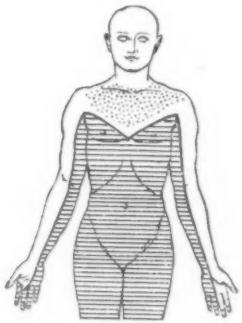


FIG. 9.

Case VI.—Herter. Anæsthesia in lesion of seventh cervical segment.

The patient fell and dislocated the sixth cervical vertebra, which crushed the eighth cervical segment and caused a softening of the seventh cervical segment with hæmorrhage, which extended upward within the central canal to the upper limit of the sixth segment. This condition was found at the autopsy made two days after the accident.

The symptoms immediately after the accident were com-

[1] *Jour. Nerv. and Ment. Dis.*, January, 1890.

plete paralysis and anæsthesia, with loss of all reflexes, excepting the left plantar reflex below the level of the armpits, the hands being noticeably weak but not paralysed. Ten hours after admission the condition of sensation was carefully determined by Dr. Herter, and is shown in fig. 9. It will be noticed that on the right side the anæsthesia involved the palmar surface of the little, ring, and middle fingers, and of the third phalanx of the index finger; on the dorsal surface it involved the little and ring fingers with the second and third phalanges of the middle finger. On the left hand the little and ring fingers were involved on both surfaces, and the middle finger on its dorsal surface excluding the first phalanx and the index finger at its dorsal top. The anæsthesia of the body was V-shaped in front and passed across the back at the seventh cervical vertebra. There was hyperæsthesia above this level—in front and behind. Deep and superficial reflexes were absent. There was retention of urine.

Within a few hours of the accident the paralysis had extended and eventually involved the muscles of both hands, the flexors and extensors of both wrists and the triceps. There was slight loss of power in the pronators and supinators, and in the biceps and pectoralis major. Both arms were abducted with forearms flexed and supinated nearly in the position described by Thorburn. The rapid extension of the paralysis and death from respiratory failure were ascribed to the extension of the hæmorrhage upward to the sixth segment. The sensory disturbance, which was the same from the first, was ascribed to the lesion at the seventh cervical segment.

It is not necessary to cite further cases,[1] although a number collected by Thorburn,[2] and by Chipault[3] and by White[4] might be offered as additional proof. It is to be

[1] The following cases may be referred to:—Bastian, *Med. Chir. Trans.*, London, 1890, vol. lxxiii., p. 152; Raymond, *Revue Neurologique*, 1893, Nos. 5 and 6; George Preston, *Med. News*, 1893, March 18; Hans Daxenberger, *Deut. Zeitschr. für Nervenheilk*, 1893, iv.; Kraus, *Zeitschr, für Klin. Med.*, xviii., 343.

[2] "Surgery of the Spinal Cord."

[3] "La Chirurgie Médullaire."

[4] "The Surgery of the Spine."

noticed that in none of these cases did the lesion destroy the sixth dorsal segment. In none of these cases was the outer surface of the hand and thumb and arm invaded by the anæsthesia. In the following cases the sixth dorsal segment was destroyed.

Case VII.—Dislocation and fracture of sixth cervical vertebra, crushing the cervical cord. Hæmorrhage in the cord. Sensory and motor symptoms.

F. H., aged 46, was brought to the Presbyterian Hospital on November 19, 1892, suffering from a fracture of the sixth cervical vertebra, due to a fall. There was tenderness and depression over the sixth and seventh spines and a projection in the pharynx. He was totally paralysed below the waist, and his arms were partially paralyzed. His urine was retained. On the next day, when I examined him, the following condition was present.

Motion.—Patient could not move from the dorsal decubitus and attempts to move his head were too painful and dangerous to be repeated. His arms were abducted, forearms flexed and hands pronated, lying on his chest, in the position described by Thorburn as characteristic of lower cervical lesions. Voluntary acts to produce these positions could be performed. He could not extend his forearms, but could flex and supinate them; all motions in the wrists and fingers were impossible upon the left side and on the right side were very feeble, there being a slight flexion and extension of the long muscles, but none of the intrinsic muscles of the hands.

There was total paralysis of the respiratory thoracic muscles, all respiration being diaphragmatic. He could not move his abdominal muscles. His legs were totally paralyzed and relaxed.

Reflexes.—Epigastric reflex absent. Abdominal and cremasteric reflexes present and normal. Knee-jerks slightly exaggerated. No ankle clonus.

Sensation.—There was total loss of all sensations in front and at the sides up to a line about the body at the

level of the seventh rib, and very marked diminution of sensations up to the level of the nipples, gradually merging into normal sensation at the level of the third intercostal space. It was not possible to test his sensation on the back, as he could not be moved. (Fig. 10.) The diminution of sensibility to all stimuli was quite well marked upon the arms, its extent being less on the right arm than on the left one. The inner side of both arms and the entire hands were quite anæsthetic, but the outer side of the forearms and arms seemed to have preserved some sensibility above the wrists, this being much more acute on the right arm

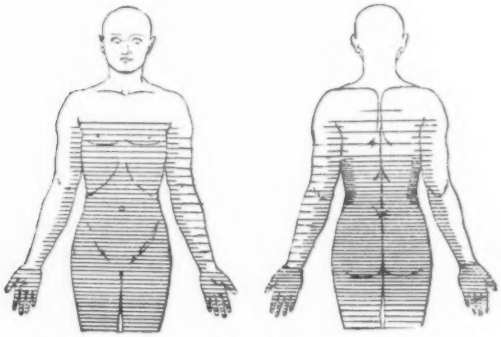
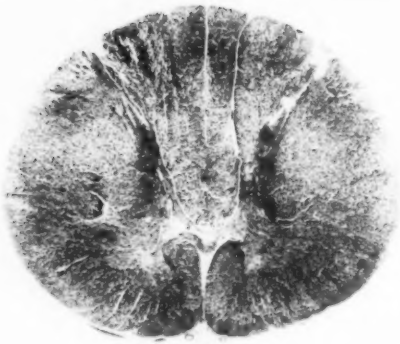


FIG. 10.

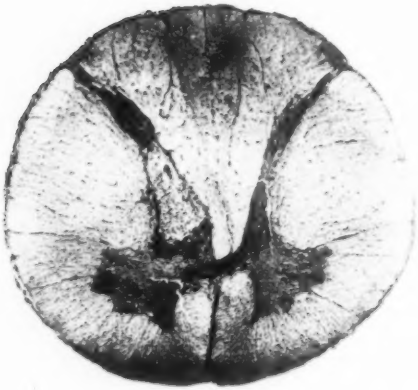
Case VII.—Starr. Anæsthesia in lesion of sixth cervical.

and forearm than on the left one. It was not until the deltoid region was reached on the left arm that he felt cotton wool as keenly as upon his face. There did not appear to be any well defined region of hyperæsthesia; yet over the region on the chest above the line of diminished sensibility he seemed to feel pain more acutely than on the face. Touch, pain, and temperature senses were equally impaired.

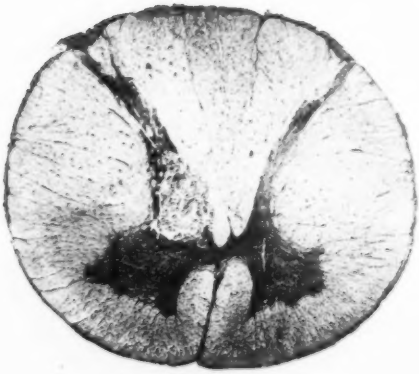
Bladder and rectum were not under voluntary control. The urine was retained and had to be drawn by catheter. Partial priapism existed. No attempt was made to empty his rectum.



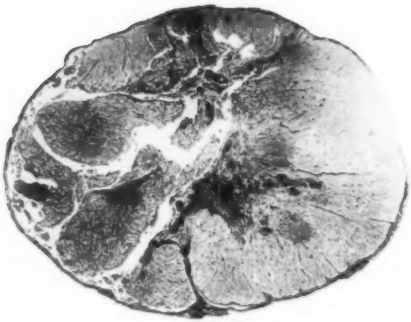
Cerv. V.



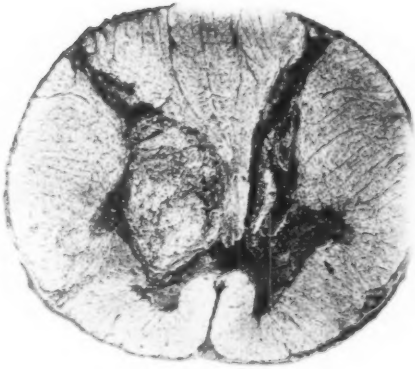
Cerv. VI.



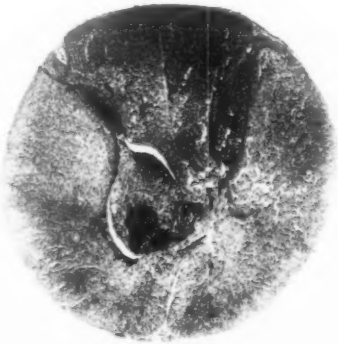
Cerv. VII.



Cerv. VIII.



Dors. I.



Dors. II.

Collotype by Dujardin & Co., London.

The pupils reacted slowly to light and in accommodation, but did not dilate when the neck was irritated. The lids were not as widely opened as they should have been. It was thought that the cilio-spinal centre had been affected.

His mind was clear up to the time of his death, which occurred about thirty-six hours after the injury; his condition remaining the same. An attempt was made to operate, but the change of position produced such disturbance of respiration that it was abandoned. The following account of the autopsy was kindly furnished me by the pathologist, Dr. John K. Thacher, and the appearance of the cord is shown in the plates made from photographs of sections prepared by Dr. Power. (Plates I. and II.)

On dissection of the vertebral column, the laminæ of the sixth cervical vertebra were found fractured, and there was a dislocation forward of the vertebral column between the fifth and sixth spinous processes, and between the bodies of the sixth and seventh vertebræ. At this point the cord was compressed and softened. Microscopical examination showed much crushing and hæmorrhage. The whole of the left half of the eighth segment was broken up, as well as the right posterior column except its posterior edge. The fibres and cells were destroyed, and there were many hæmorrhages, especially in the gray matter. The gray matter of the right side was broken up, especially at the anterior part of the posterior horn and showed some extravasation of blood. But the tip of the posterior horn and some of the anterior portions of the anterior horn appeared uninjured, as did also the anterior and lateral columns of white matter.

Passing upwards from the segment crushed, to the seventh segment, a spot of disintegration and hæmorrhage was found involving the anterior half of the left posterior horn and a little of the adjacent anterior horn and lateral and posterior white column. The hæmorrhage also extended in a narrow line along the outer edge of the posterior horn nearly to the surface of the cord.

In the sixth segment the same appearances were found, but in the fifth the tissues were normal.

Passing downwards to the dorsal region of the cord, in the first dorsal segment a displaced mass of white matter was noticed replacing most of the gray matter of the left side and surrounded by a zone of hæmorrhage. On the right side there were numerous hæmorrhages scattered through the gray matter, and apparently a small displaced mass of white matter in the base of the posterior horn.

In the second dorsal segment the lesion on the left side was similar to that in the previous segments, but a little smaller. On the right side no hæmorrhages were seen in the anterior horn, but in the posterior horn was a long narrow oval hæmorrhage running nearly the entire length of the horn.

In the third dorsal segment no lesion was to be seen on the left side, but in the right posterior horn the same hæmorrhage found in the preceding segment was again found, though smaller.

Below the third dorsal segment the cord appeared to be normal.

Summary.—The lesion, therefore, consisted of a disintegration of the cord at the eighth cervical segment and a hæmorrhage in the two segments above and below this, especially on the left side of the cord.

In regard to the area of anæsthesia upon the body it is to be noticed that it was much below the level of the lesion. Sensations were felt in slight degree above the level of the seventh rib; they were fairly well felt above the nipples, they were quite normally felt above the third rib. This preservation of sensation upon the body at a level some distance below the lesion, is not unusual. I have careful records of several cases of transverse myelitis in the dorsal region with autopsies in which this condition has been noticed. And the cases reported by Church and Eisendrath[1] may be cited in confirmation of the fact. It is noticed that, except on the ulnar side of the forearms and arms and in the hands, the anæsthesia in my case was not total. The hands were both totally anæsthetic.

[1] *Am. Journ. Med. Sci.*, 1892.

Case VIII. — Caries of cervical vertebra. Brown-Séquard paralysis. Death.

A girl of 15, previously in good health, noticed in August that her neck was becoming stiff and painful on motion. The pain was in the course of the great occipital nerves, and by October her head had become so rigid that no active or passive motion of the neck was possible. During October weakness in the arms, especially in the left arm, began, and soon the left leg also became weak. She was sent to my clinic on October 22, and then presented the following symptoms. The head was held rigid, turned slightly to the right, the chin slightly elevated, and passive motion was prevented by the rigidity of the deep muscles of the neck as well as by a deformity of the spine, which was evident both by a deep hollow in the neck at the fourth and fifth cervical vertebræ and by a projection at the back of the pharynx. Pain in the neck and over the back of the head was a prominent symptom, but was not associated with anæsthesia. The left upper extremity was partially paralysed, all movements being very much impaired; those at the shoulder and elbow joints more than those at the wrist and fingers. No motion of the arm was possible, it hanging helpless. Motions of the forearm were very weak, extension being impossible; the forearm was semiflexed upon the arm. While all the fingers could be moved, she had no grip. The triceps and wrist tendon reflexes were greatly exaggerated, a triceps clonus being obtained. All sensations were perceived equally in the left side and in the face; and the muscular sense was keen and quick.

The left lower extremity was weak, both at hip, knee, and ankle joints, and the tendon reflexes were much exaggerated. The sensation was normal; that is, the same as in the face.

The right upper extremity was freely moved, but was markedly anæsthetic up to the shoulder. Tactile sensations, sensations of pain, heat, and cold were not perceived by any means as promptly, as accurately, or as intensely as in the corresponding part of the opposite limb. There was marked

ataxia of movement in the right hand when her eyes were closed: and the perception of its position was less rapid and accurate than on the left side. There was no motor paralysis and no increase of tendon reflexes.

The right lower extremity was not paralysed, the knee-jerk was normal, no ankle clonus was obtained. The same kinds of anæsthesia were found as on the right arms, though sensations were rather better in the lower than in the upper extremity. The area of anæsthesia is shown in fig. 11.

The gait was much impaired. She staggered in standing and walking, with a tendency to fall toward the right when her eyes were closed, and her gait was decidedly ataxic.

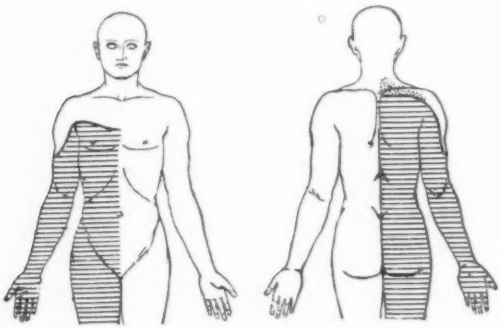


FIG. 11.

Case VIII.—Starr. Anæsthesia in lesion of fifth cervical segment.

The control of the sphincters was somewhat impaired. She had to wait a long time before her water would pass, and a loss of voluntary control of the bladder soon ensued, so that a catheter had to be used.

There was no hyperæsthesia of the paralysed side and no band of anæsthesia about the trunk on that side.

By the end of November, all of the symptoms had increased in intensity, the paralysis of motion of the left side being complete, and the anæsthesia on the right side being increased; she was unable to sit up or to control her sphincters. She had distressing attacks of dyspnœa.

The condition finally became one of total paraplegia, and in January she died.

Diagnosis.—It was evident from the first that a caries of the fourth and fifth cervical vertebræ had resulted in a displacement of these bones, which had produced pressure upon the left half of the spinal cord at the level of the fifth and sixth cervical segments. That these segments or their nerves were seriously implicated was evident from the fact that a marked atrophy, as well as paralysis and a reaction of degeneration, was found to exist in the deltoid, biceps, triceps, supinator longus, supra and infra spinatus, and pectoral muscles of the left arm, while no such atrophy or reaction was found in the other muscles in spite of their paralysis. In the right arm the anæsthesia was more marked over the back of the shoulder and arm and on the outer side of the arm and forearm than elsewhere. The pressure was sufficient to cut off, to some extent, motor impulses downward to the left leg on the side diseased, and sensory impressions of all kinds from the right side of the body below the level of the lesion.

Operative interference appeared to be impossible, and the disease made rapid progress, producing finally total paraplegia and death from respiratory paralysis. An autopsy was not made.

With the cases already cited it would easily be possible to lay down certain districts of skin upon the upper extremity, and assign each district to its segment of the cervical cord. It would be possible to cite also numerous cases of stab wounds of the cord and of tumours of the cord which confirm these conclusions.[1] But did we attempt this the objection might reasonably be raised that from traumatic cases where shock cannot be excluded and where temporary effects cannot be wholly distinguished from permanent effects such conclusions would be unwarranted.

The following case, however, is not open to this objection, and appears to afford exactly such information as is needed to enable an exact localisation to be reached.

[1] Incised wounds of the spinal cord. Neumann, *Virchow's Arch.*, cxxii. h. 3. Sachs, *Jour. Nerv. and Ment. Dis.*, xiii., November, 1886.

It is a case of sarcoma growing upon and invading the cord upon one side, beginning at the lower cervical and first dorsal segments, and extending gradually to other segments. As the sarcoma grew the anæsthesia increased in extent.

Case IX.—Tumour of the lower cervical region of the cord with progressive anæsthesia.[1]

Male, 29, began to suffer in May, 1891, from numbness in the ulnar side of the right little finger. The numbness, which was attended by actual anæsthesia, gradually extended to the entire little finger, then to the ring finger and then to the ulnar side of the middle finger. As it extended to the ring and middle fingers it extended to the ulnar surfaces of the hand, and then gradually up the ulnar surfaces of the forearm and arm, to the axilla which were anæsthetic in August, 1891. Later, the anæsthesia increased upon the hand, gradually reaching the thumb, and then including it; and finally advanced up the radial border of the forearm and arm to the insertion of the deltoid, at which point it ceased about thirteen months after the onset. Parallel with this extension of sensory loss there was a gradual extension of paralysis with atrophy and reaction of degeneration. The paralysis began in the interossei and hypothenar eminence, then invaded the thenar eminence, then the long flexors of the fingers, and then all the muscles of the forearm except the supinator. The muscles became rigid before they were paralysed, but relaxed again as degeneration set in. In the course of the year all the muscles of the arm became involved and paralysed except the supinator longus and the deltoid; the pectoralis major and shoulder muscles became rigid. From the first it was noticed that the right palpebral fissure was small, that the right lid drooped and that the right pupil was small.

In September, 1892, the patient died, a large sarcoma having developed in the chest.

[1] Ross and Herter, *New York Medical Record*, August 12, 1893. It is interesting to note that though the tumour was confined to one side of the cord the symptoms were not those of Brown-Sequard paralysis. The same fact was noted in a case of spinal cord tumour seen by me with Sachs, and fully reported by him.

The autopsy showed a small sarcoma lying upon and invading the spinal cord on the right side, extending up as high as the fifth cervical segment and as low as the third dorsal segment, but being largest at the lowest cervical and first dorsal level.

A somewhat similar case has been recently reported by Murray and Johnson,[1] and several others might be cited of either tumour or myelitis advancing up the cervical cord and producing a gradual extension, both of paralysis and of anæsthesia. As the symptoms, however, in all these cases are identical, it does not seem worth while to cite them in full.

There are certain other facts which may be mentioned as affording confirmatory evidence of the areas of skin corresponding to the segments of the cervical enlargement. It is well-known to everyone who has watched the progress of cases of locomotor ataxia of the ordinary progressive type that as the disease ascends the cord the numbness and pain begin in the upper extremity in the little finger, then extend to the ring finger and then up the inner border of the hand and forearm. Finally the entire hand becomes numb and the thumb is the last to be ataxic. Thus the extension of the sensory symptoms in this disease corresponds quite exactly with that which has just been described in the case of cervical tumour.

There is also a disease which quite commonly invades the upper part of the cervical cord, viz.: chronic hypertrophic pachymeningitis. It is to be remembered that in this disease the pain is felt chiefly in the neck over the tops of the shoulders and in the outer side of the arms, and only rarely in the forearms and hands. The characteristic position of the hand and wrist pictured by Charcot[2] is explained by him as due to contracture of the muscles irritated by invasion of the nerves from above downward, the radial and median being affected, the ulnar escaping. Thus we see the exact converse of the picture presented by the advance of the disease locomotor ataxia.

[1] *Medico-Chirurgical Transactions*, vol. lxxv., p. 47, 1892.
[2] *Leçons sur les Mal. du Syst. Nerv.*, vol. ii., p. 251.

Conclusions.

There are a number of interesting facts to be drawn from the study of the cases here collected.

First, as to the distribution of anæsthesia in lesions of the cervical enlargement of the spinal cord. By combining the diagrams already given with numerous other diagrams

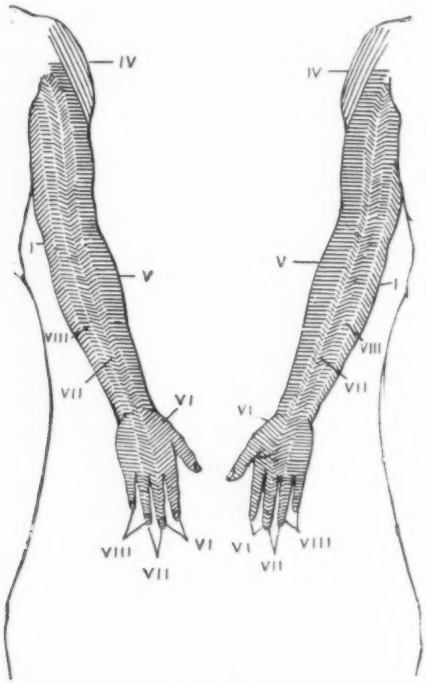


Fig. 12.

Diagram to show the area of skin upon the upper extremity related to the different segments of the spinal cord from first dorsal to fourth cervical.

published by Thorburn and others, and comparing the results with descriptions of numerous cases collected by Chipault, White and other surgeons, it is possible to produce a schematic diagram such as is here presented demon-

strating the areas of skin upon the arm which are related to the various segments of the cord between the second dorsal and the fourth cervical. (Fig. 12.)

(1) The first area is a narrow one upon the inner side of the arm and forearm extending down to the wrist but not involving the hand. This includes a small zone both upon the dorsal and palmar surfaces of the arm and forearm, but is quite narrow. While it is probable that the upper portion of this area in the axilla is related to the second dorsal nerve, as Head maintains, I can find no exact lesion of the cord limited to the second dorsal segment and associated with such a limited anæsthesia to prove this statement.

There is a case reported by Charcot[1] in which a bullet wound involved the first dorsal nerve only, and in which a small area in the axilla remained sensitive; the other parts included in area number one being anæsthetic, but as no examination of the cord was made in this case the conclusion drawn from it is of no more weight than that which might be drawn from a knowledge of the anatomy of the intercostal humeral nerve. Area number one corresponds to the first dorsal segment.

(2) The second area includes the ulnar side of the hand, both palmar and dorsal surfaces, the little finger and one half of the ring finger. It also includes a narrow strip of the skin upon the dorsal and palmar surfaces of the arm up to the axilla. This is proved by the fact that when lesions invade the eighth cervical segment of the cord the zone of anæsthesia upon the front and back of the arm and forearm is decidedly wider than when the first area alone is anæsthetic. It affords also a confirmation of the statements of Sherrington that there are no isolated patches of skin entirely separated from the body related to the sensory nerves. The second zone corresponds to the eighth cervical segment.

(3) The third zone extends to the middle line of the middle finger, includes the middle of the palm and back of the hand, and runs up the centre of the forearm and arm on both surfaces. This corresponds to the seventh cervical segment.

[1] *Arch. de Neurol.*, 1891.

(4) The fourth zone includes the remaining skin of the fingers and thumb and of the hand as high as the wrist and a narrow strip of skin up the forearm and arm on both surfaces to the axilla. This corresponds to the sixth cervical segment.

(5) The fifth zone includes the skin upon the outer side of the forearm and arm on both surfaces as high as the insertion of the deltoid muscle. This corresponds to the fifth cervical segment.

(6) The fact that in lesions as high as the fifth segment hyperæsthesia occasionally occurs over the top of the shoulder and in the region of the supra-clavicular nerves, leads us to believe that the fourth cervical segment is in relation with this area. But inasmuch as lesions of the fourth segment of a destructive nature are uniformly fatal no case of anæsthesia can be found to determine the exact extent of skin which corresponds respectively to the fourth and third cervical segments.

It is hardly necessary to point out the differences between the areas of anæsthesia produced by cord lesions and those produced by lesions of individual nerve trunks, although a glance at the diagram and its comparison with Flower's well-known plates show this immediately. It is also evident that a contrast of the anæsthesia occurring in spinal cord lesions with that occurring in multiple neuritis affords an important point of diagnosis between these two conditions. It will be remembered that in multiple neuritis, the anæsthesia affects all the fingers simultaneously, then the entire hand, and then extends up the arm, involving all surfaces on both sides in an area which has been aptly described as the "glove area" corresponding as it does to the region of skin covered by a glove of various lengths. I have never seen a case of multiple neuritis in which the anæsthesia extended as high as into the axilla. It is usually limited by a line drawn around the elbow or a line in the middle of the arm.

Lastly, the area of anæsthesia occurring in hysterical conditions is different from that described as occurring in spinal lesions, for there is never the patch of normal

sensitive skin over the top of the shoulder and down the outer side of the arm to the insertion of the deltoid such as we have seen in all the cases of spinal lesions; and in hysterical anæsthesia it is well known that the neck is usually anæsthetic.

Clinical observers in the future should attempt by the aid of diagrams to define a little more exactly the region of the anæsthesia in the arm and should also seek for a narrow zone of hyperæsthesia separating the normal skin from the insensitive region, which zone will necessarily be very narrow in the upper extremity. In discussing the anæsthesia from lumbar lesions, I was able to show that such a zone of hyperæsthesia often existed of a most irregular shape in unexpected areas which were easily explained when the exact region of the skin, corresponding to the segment just above the lesion was determined.[1]

Secondly, lesions in the lower cervical region of the cord produce a number of symptoms due to a lesion of the cilio-spinal centre which have been frequently overlooked by observers. The situation of this centre is in the first dorsal segment of the cord, and according to Klumpe,[2] the symptoms are only produced by a lesion of the cord, or of its nerve roots, not by a lesion of the nerves after they have issued from the spinal canal and formed the brachial plexus.

The symptoms alluded to are myosis, with sluggish reaction of the pupil both to light and in accommodation, a decided narrowing of the palpebral fissure, so that the eye-ball looks smaller than normal, and a slight retraction of the eye-ball. There is no flattening of the face, nor are there any vaso-motor symptoms such as may be produced by a lesion in the course of the cervical sympathetic nerve. These symptoms are very easily overlooked if they are present upon both sides. But when the lesion has been unilateral they have been noted by a number of observers.

Kraus[3] has described them in a number of cases of trau-

[1] *L. c.*, see Cases V. IX. and XII.

[2] Klumpe, *Rev. de Med.*, 1885, No. 7 and 9.

[3] Kraus, *Zeitsch. für Klin. Med.*, vol. xviii.

matic injury of the cervical cord due to fracture of the seventh cervical vertebra.

In a case of unilateral compression of the cord by a fracture of the seventh cervical vertebra which I recently saw with Dr. Bryant, at St. Vincent's Hospital, these symptoms were very noticeable upon the left side. I believe with Kraus that a more careful observation will reveal the existence of these symptoms on both sides in all cases of a crush of the lower part of the cervical and upper dorsal region.

Thirdly, a careful study of the cases here collected furnishes additional evidence in regard to the localisation of the motor functions of the spinal cord. This serves to confirm very fully statements made by me in 1884,[1] and again in 1888,[2] in regard to the representation of the various muscles of the upper extremities in different segments of the cervical region.

In the articles alluded to, it will be found that every muscle is assigned a representation in more than one segment of the cord, and this fact has been accepted by Mills[3] and by Kaiser.[4] It is well-known that the groups of cells in the anterior horns of the cord have a considerable extent vertically, so that some groups are long enough to reach through two or even three segments and but very few groups can be said to be situated in one segment only. But inasmuch as these groups of cells govern individual muscles, as we must believe in view of the facts known regarding anterior poliomyelitis, it is evidently a mistake to assign the representation of single muscles to single segments. I cannot therefore adopt the arrangement proposed by Thorburn[5] and copied by Collins,[6] in which individual muscles are assigned to single segments.

If cases such as these here collected are carefully studied it will be found that a lesion limited to one segment rarely paralyses any muscle completely. If, however, the lesion

[1] *Amer. Jour. of Neurology*, August, 1884.
[2] *Amer. Jour. Med. Sci.*, May, 1888.
[3] C. K. Mills, *Therapeutic Gazette*, May and June, 1889.
[4] O. Kaiser, *Die Functionen der Ganglienzellen des Halsmarks*, Haag, 1891.
[5] *Loc. cit.*
[6] *New York Medical Journal*, February, 1894.

extends through two or more segments the paralysis is complete. Or, if a lesion is a progressive one extending either upward or downward, it will be found that the muscles will be paralysed in greater and greater degree as the lesion extends. These facts are only to be explained upon the theory that individual muscles have a considerable vertical representation in the cord, and this as we have already seen corresponds to the anatomy of the groups of cells. The following table, therefore, presents the facts in an accurate manner.

I am quite prepared to admit that the vertical extent of individual groups of cells may vary in different individuals. Thus in cases carefully studied by Beevor and by Johnson, the lesion, though involving the sixth cervical segment, caused no paralysis of the biceps; while on the other hand, in one of Herter's cases the biceps was decidedly involved by a lesion of the sixth segment. It is, therefore, probable that the representation of muscles is not always the same in different cords. The table, however, may be considered as fairly accurate because it combines a large number of facts derived from the study of very many cases. It is, perhaps, more accurate than the earlier tables. In recent cases care has been taken to examine the paralysed muscles electrically, and the existence of the reaction of the degeneration is certainly a positive proof that the groups of cells governing the muscles have been destroyed.

In conclusion, I think it may be stated that the sensory and motor functions of the cervical region are now as well determined as those of the lumbo-sacral region of the spinal cord.

The plates show the disintegration of the spinal cord at the eighth cervical segment, and the hæmorrhage into the cord in the segments above and below it in Case VII.

TABLE SHOWING THE MUSCLES REPRESENTED IN GROUPS OF CELLS IN THE VARIOUS CERVICAL SEGMENTS OF THE SPINAL CORD.

IVc.	Vc.	VIc.	VIIc.	VIIIc.	ID.
Diaphragm. Lev. Ang. Scap. Rhomboid. Supra & Infra Spin. Deltoid. Supin. long. Biceps.	Rhomboid. Supra & Infra Spin. Deltoid. Supin. long. Biceps. Supin. brev. Serratus mag. Pect. (clav.) Teres minor.	Biceps. Serratus mag. Pect. (clav.) Pronators. Triceps. Brach. Ant. Long Extensors of Wrist & Fingers.	Pronators. Triceps. Brach. Ant. Long Extensors of Wrist & Fingers. Pect. (costal). Latis. dorsi. Teres major. Long Flexors of Wrist & Fingers.	Long Flexors of Wrist & Fingers. Extensor of Thumb. Intrinsic Muscles of Hands.	Extensor of Thumb. Intrinsic Muscles of Hands.

Reviews.

(I.)—*Klinische und anatomische Studien über die Pellagra.* Von Dr. Franz Tuczek, Berlin, Kornfeld, 1893.

(II.)—*Arbeiten aus dem Institut für Anatomie und Physiologie des Centralnervensystems, an der Wiener Universität.* 2 vols. Edited by Prof. Obersteiner, Leipzig, Deuticke, 1892-1894.

(I.)—This book, of over a hundred pages of letterpress, and ten pages of plates, is, as the author informs us in the preface, the result of a tour of investigation through the pellagrous districts of Italy. Its avowed object is partly to excite the interest of the writer's German colleagues, especially neuropathologists, partly to contribute something to the morbid anatomy of pellagra. But we venture to think that the book will appeal to a wider audience than the author in his modesty aims at, for it is marked by intimate personal knowledge of the subject, having a succinctness to which completeness is not sacrificed, and it is enriched with some suggestive remarks on the interesting class of toxic diseases of which pellagra is now, on apparently quite sufficient grounds, believed to be an example. It will be enough here briefly to indicate the nature and arrangement of the contents.

After a few pages of introduction in which toxic diseases and their selective action on different parts of the nervous system are dealt with, a short historical account is given of the first appearance of pellagra, and its gradual diffusion from the province in Spain in which it arose over Italy the South-west of France, Roumania, and Corfu, its ravages so far being almost confined to European countries, and becoming, in some parts of Italy, nothing less than a national calamity. This will be appreciated from the fact that in 1884, over ten thousand cases of pellagra were treated in Italian hospitals and asylums. The etiology of the condition seems to be clearly traceable to the use of maize, but this will only produce it if it is damaged in some way. In the Italian domicile of the disease, the maize often does not come to maturity and is therefore easily exposed to damage; its use in this damaged state apparently gives rise to the disease. This is made more evident by the fact that it prevails mostly in years of bad harvest, in which the corn is cut before it is ripe, and is gathered while still damp. It is supposed that in this damaged state some substance is produced which acts as a poison to the nervous system, and it is significant that a spirit distilled from this damaged maize can also evoke the symptoms of pellagra. The various predisposing causes are next briefly alluded to, and the different forms in which the disease manifests itself. Its various stages are also considered, the first, in which the symptoms are mainly premonitory, a second characterized mainly by cerebral or spinal disturbances and psychical changes, and a third or cachetic state with its various phases. The rest of the book is devoted to the setting out of the clinical symptoms of numerous cases and the morbid anatomy of several. In conclusion, the curiously symmetrical changes in the spinal cord are described, affecting both lateral and posterior tracts, and closely

resembling the condition of the cord recently described in association with anæmia. These changes are figured in a series of well executed plates, while a successful collotype representation of the condition of the skin which gives the name to the disease, and a map showing its distribution in Italy, give completeness to a most excellent monograph.

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(II.)—These volumes contain a number of valuable contributions to the anatomy and pathology of the nervous system. Dr. Emil Redlich has an exhaustive article "On the Posterior Roots of the Spinal Cord and the Pathological Anatomy of Tabes Dorsalis," and his conclusions, that the first parts to be affected are the posterior roots within the spinal cord confirm the observations of Leyden, Marie, Takács and Dejerine. The determination of the exact starting point of the degenerative process has been made the subject of special inquiry by Redlich and Obersteiner in a paper "On the Nature and Pathogenesis of the Tabetic Degeneration of the Posterior Columns." By making oblique sections so as to cut the posterior root in the direction of its entrance into the spinal cord they find that the pia mater causes, in the normal state, a considerable constriction of the roots, the constriction being caused for the most part by the circular fibres of the pia, one or two vessels also taking part in its formation. Between the constriction and the cord itself the fibres of the posterior roots lose their medullary sheaths for a short distance and the axis cylinders are unprotected.

In locomotor ataxia, even in early cases, the roots on the spinal side of the constriction are degenerated. The cause of this degeneration is a chronic hyperplasia of the connective tissue of the pia mater which forms the constriction. This presses on the nerve fibres, and leads to degeneration. As the fibres which go to Lissauer's boundary zone lie peripherally in the posterior roots, it becomes apparent why the boundary zone suffers so early in this disease. The degeneration of the posterior roots outside the cord is probably due to the same cause, and the degenerative process may even extend to the ganglion cells of the spinal ganglia, as has been shown by Raymond. The tendency of syphilis to produce a chronic hyperplasia of connective tissues, readily explains the frequency of locomotor ataxia as a sequela of this disease. Instead of the chronic inflammation of the pia, a gummatous infiltration may occur without necessarily leading to degeneration of the nerve fibres (syphilitic pseudotabes).

The pathological anatomy of *paralysis agitans* is also treated by Redlich, and his observations confirm in the main those of Koller and Ketscher. He distinguishes between purely senile changes, such as blocking of the central canal and pigmentation of the ganglion cells, and changes which are characteristic of the disease. These occur in the spinal cord and medulla, and begin as endo- and periarteritis. This leads to sclerosis of the connective tissue of the cord, and indirectly to degeneration of the nerve fibres. The cervical and lumbar enlargements are the parts most affected, especially the posterior columns and crossed pyramidal tracts. The greater affection of the cervical region may probably explain the characteristic rigidity of the upper limb and neck muscles; while periarterial sclerotic foci in the medulla might cause the characteristic disturbance of speech. For further details, however, reference should be made to the original papers.

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